

## Virtual store layout: an experimental comparison in the context of grocery retail

Adam P. Vrechopoulos<sup>a,\*</sup>, Robert M. O’Keefe<sup>b</sup>, Georgios I. Doukidis<sup>a</sup>, George J. Siomkos<sup>c</sup>

<sup>a</sup> *ELTRUN-The E-Business Center, Department of Management Science and Technology, Athens University of Economics & Business, 47A Evelpidwn & 33 Lefkados, 113-62, Athens, Greece*

<sup>b</sup> *School of Management, University of Surrey, Guildford, Surrey GU2 7XH, UK*

<sup>c</sup> *Department of Business Administration, Athens University of Economics & Business, 76 Patision Street, 104 34, Athens, Greece*

---

### Abstract

Interface design and the interaction between customer and computer are factors critical to business effectiveness over the Web. A key aspect of conventional retailing is store layout; an analogous aspect in virtual retail is *virtual store layout*. This paper reports on an experimental investigation into the use of three different layouts in online grocery retailing: freeform, grid, and racetrack. These three most common conventional retailing layout types were transformed into virtual layouts for computer-mediated interfaces. Subjects in Greece and the UK participated in a laboratory experiment: they were given a planned shopping task with money to spend, and performed their shopping through a virtual store with layout as the manipulated variable. The results show that layout significantly affects online consumer behavior, but that predictions generated from the literature of conventional retailing about differences in the outcome of layouts do not generally hold in a virtual setting. Some of the findings can be explained by reference to research in Human Computer Interaction (HCI).

© 2004 by New York University. Published by Elsevier. All rights reserved.

**Keywords:** Virtual store layout; Grocery retailing; Conventional retailing

---

### Introduction

The promise offered by electronic commerce and virtual retailing will depend to a great extent upon interface design and the way that customers interact with the computer (Burke, 2002). Lohse and Spiller (1998) state that online store layouts have a critical influence on traffic and sales, while Burke (2002) shows that the characteristics of a virtual layout determine buyers’ willingness to purchase through the Internet. Along the same lines, Siomkos and Vrechopoulos (2002) report that virtual store layout design constitutes one of the core elements of virtual retailing, and that retailers need to be aware of its effects on online consumer behavior in order to be able to manipulate it accordingly. Until now, however, there has been little empirical evidence regarding the impact of virtual store layout on consumers’ buying behavior (Eroglu, Machleit, & Davis, 2001); several researchers (Burke, 2002; Lohse and

Spiller, 1999, etc.) strongly argue for research to address this.

Focusing on the impact of different virtual store layouts on consumer buying behavior, this paper tests whether conventional retailing store layout theory can be applied in its present form in the context of virtual retailing. To that end, the three most common conventional retailing layout types (grid, freeform, and racetrack) were transformed into virtual layouts for computer-mediated interfaces over the Web and tested on real customers within a laboratory experimental setting.

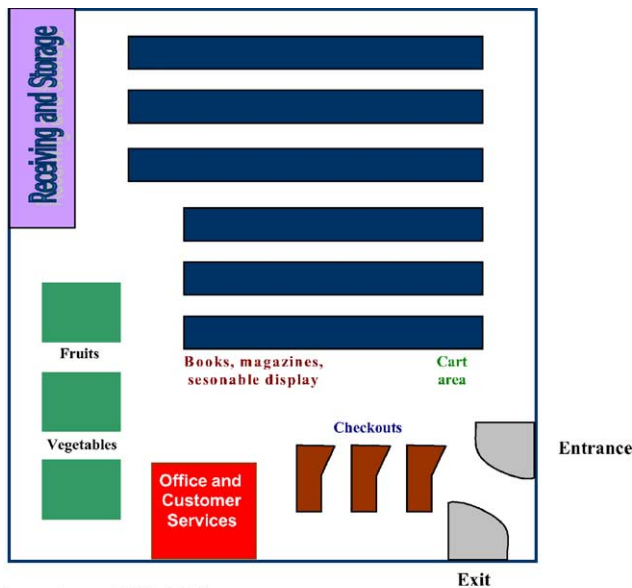
### Store layout in conventional retailing

Store image is an important factor affecting consumer behavior (Erdem, Oumlil, & Tunculp, 1999), and store layout design is a critical determinant towards the creation of that store image (Baker, Grewal, & Parasuraman, 1994; Baker, Parasuraman, Grewal, & Voss, 2002). Lewison (1994, p. 289) states: “selling floor layouts are extremely important because they strongly influence in-store traffic patterns, shopping atmosphere, shopping behavior, and operational

---

\* Corresponding author. +30-210-8203654; fax: +30-210-8203685.

E-mail addresses: avrehop@aueb.gr (A.P. Vrechopoulos), R.Keefe@surrey.ac.uk (R.M. O’Keefe), gjd@aueb.gr (G.I. Doukidis), gsiomkos@aueb.gr (G.J. Siomkos).



Source: Levy and Weitz (2001)

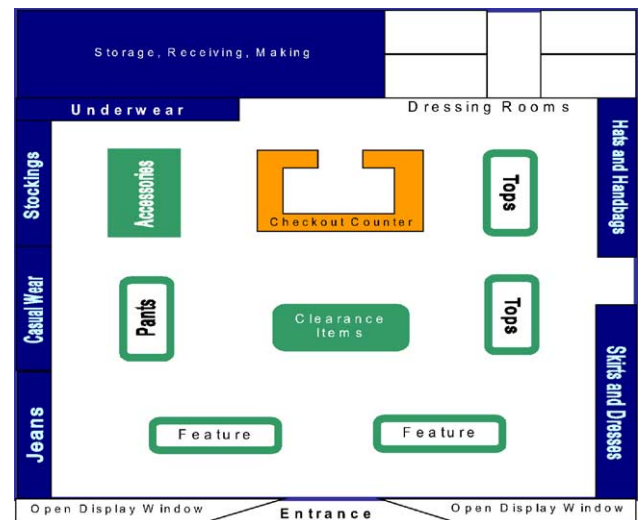
Fig. 1. Grid store layout.

efficiency.” Similarly, Merrilees and Miller (2001) report that store layout design is one of the more important determinants of store loyalty, and Simonson (1999) states that store layout design can play a key role not only in satisfying buyers’ requirements but also in influencing their wants and preferences. Along the same lines, Grewal and Baker (1994) note that store layout affects consumers’ price acceptability, which is positively related to purchase intentions, while Baker, Grewal, and Levy (1993) find a relationship between positive experiences in a retail context and willingness to buy. Merrilees and Miller (2001) also report that superstores are currently revolutionizing the nature of retail service, mainly by creating more effective self-service arrangements as a result of improvements in store layout design.

#### Major store layout types in conventional retailing

According to established conventional retailing store layout theory (Ghosh, 1994; Mason, Mayer, & Ezell, 1991; Levy & Weitz, 2001; Lewison, 1994), there are three major types of store layout (Figs. 1–3):

- Grid:** The grid layout is a rectangular arrangement of displays and long aisles that generally run parallel to one another. It has been showed that the grid layout *facilitates routine and planned shopping behavior*, providing consumers with flexibility and speed in identifying pre-selected products which appear on their shopping list (Levy & Weitz, 2001; Lewison, 1994). It is widely favored by the grocery sector because the majority of customers visiting grocery stores have planned their purchases.
- Freeform:** The freeform layout is a free-flowing and asymmetric arrangement of displays and aisles, employ-



Source: Levy and Weitz (2001)

Fig. 2. Freeform store layout.

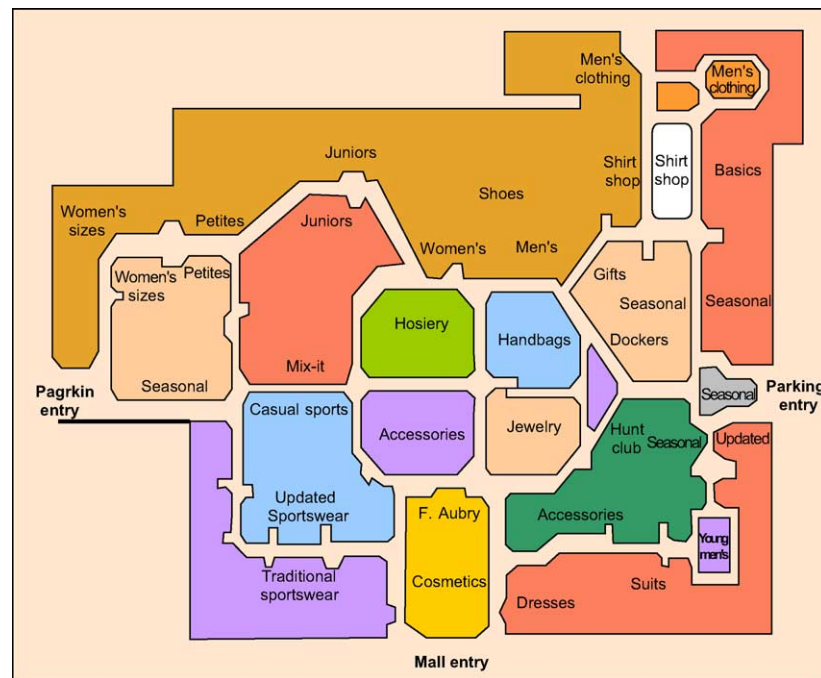
ing a variety of different sizes, shapes, and styles of display. In this pattern, the customer enjoys considerable freedom to move in any direction within the store. It is mainly used by large department stores (e.g., fashion stores). The freeform layout has been shown to *increase the time that consumers are willing to spend in the store*; it has an *easy to use structure*, making it easier for shoppers to browse (Levy & Weitz, 2001; Lewison, 1994; Mason et al., 1991).

- Racetrack/boutique:** In the racetrack/boutique layout, the sales floor is organized into individual, semi-separate areas, each built around a particular shopping theme. The racetrack/boutique store layout leads the customer along specific paths to visit as many store sections or departments as possible, because the main aisle/corridor facilitates customer movement through the store. The retailer who adopts this layout creates an unusual, interesting, and *entertaining shopping experience* (Lewison, 1994).

#### Virtual retailing layout: current business practice

We undertook to compare our experimental layouts (freeform, grid, and racetrack), as they were derived through the transformation process discussed later in the paper (Fig. 5), with common practice in UK and Greek online grocery stores.

The results of an ad hoc investigation (Table 1) indicate that Sainsbury’s and Tesco, the UK’s two largest grocery retailers (and two of the five largest retailers in Europe), both use a design that we can classify as a mixed grid/freeform layout, as does Waitrose, one of the top five UK retailers. However, the two other major UK grocery retailers, Sainsbury and Asda, use a grid layout with limited search



Source: Levy and Weitz (2001)

Fig. 3. Racetrack store layout.

Table 1  
Layout use by major UK and Greek online grocery stores

United Kingdom				Greece	
Stores	Layout type	Stores	Layout type	Stores	Layout type
<a href="http://www.tesco.com">www.tesco.com</a>	Mixed grid-freeform	<a href="http://www.uk.shopsmart.com">www.uk.shopsmart.com</a>	Mixed grid-freeform; limited search	<a href="http://www.smartbuy.gr">www.smartbuy.gr</a>	Freeform
<a href="http://www.sainsburys.co.uk">www.sainsburys.co.uk</a>	Mixed grid-freeform	<a href="http://www.waitrose.com">www.waitrose.com</a>	Mixed grid-freeform	<a href="http://www.veropoulos.gr">www.veropoulos.gr</a>	Grid with limited search
<a href="http://www.iceland.co.uk">www.iceland.co.uk</a>	Grid with limited search mechanisms	<a href="http://www.foods-online.co.uk">www.foods-online.co.uk</a>	Racetrack	<a href="http://www.grproducts.gr">www.grproducts.gr</a>	Grid with no search mechanisms
<a href="http://www.safeway.co.uk">www.safeway.co.uk</a>	Grid with limited search mechanisms	<a href="http://www.absolutorganic.co.uk">www.absolutorganic.co.uk</a>	Freeform implemented in aisles	<a href="http://www.homenet.gr">www.homenet.gr</a>	Freeform implemented in aisles
<a href="http://www.asda.co.uk">www.asda.co.uk</a>	Grid with limited search mechanisms	<a href="http://www.simplyorganic.net">www.simplyorganic.net</a>	Racetrack	<a href="http://www.shop.gr">www.shop.gr</a>	Mixed grid-freeform
<a href="http://www.johnlewis.com">www.johnlewis.com</a>	Mixed grid-racetrack	<a href="http://www.carblife.co.uk">www.carblife.co.uk</a>	Grid with no search mechanisms	<a href="http://www.greekmarket.gr">www.greekmarket.gr</a>	Grid with no search mechanisms

mechanisms. Some smaller UK retailers (e.g., John Lewis) employ a mixed grid-racetrack layout, while others employ either a pure racetrack (e.g., Foods Online) or a freeform layout (e.g., Absolute Organic).

In Greece, Veropoulos, one of the major retailers, uses a grid layout. It should be noted, however, that the major “bricks-and-mortar” retailers in Greece have not introduced online grocery facilities so far; the Greek sample, therefore, comprises some dedicated online firms. Shop.gr uses a mixed grid/freeform layout; the rest employ either a grid layout without providing search mechanisms, or a freeform layout mainly implemented using aisles.

The aforementioned findings confirm the insights provided by a similar research study conducted by Vrecho-

poulos, Papamichail, and Doukidis (2002). They used a sample of 551 retail websites from six different countries around the globe and they found that the freeform layout is employed by 51.3% of the investigated websites, while grid and racetrack layouts are employed by 21.2 and 1.5% of the sites, respectively. The rest (26%) are not classified in any of the aforementioned categories.

### Research hypotheses and methodology

According to the conventional retailing research insights discussed above, store layout affects a series of consumer behavior-dependent variables in a certain manner. The

following research hypotheses aim to test whether the same phenomena occur in a virtual setting. However, because the present study focuses specifically on the effects of grid, freeform and racetrack layouts on online consumer behavior, the dependent variables of our research design are based on the corresponding findings discussed above (i.e., those findings that are related to the grid, freeform, and racetrack effects on consumer behavior). The research hypotheses aim, therefore, to investigate whether and how each layout affects online consumer behavior in terms of: (a) *facilitating planned purchases*, (b) *easy navigation within the store*, (c) *perceived entertainment*, and (d) *time spent within the store*.

“*Perceived Usefulness*” (PU) and “*Ease of Use*” (EOU) employed for testing Hypotheses 1 and 2, respectively, constitute two of the Technology Acceptance Model’s (TAM) constructs (Davis, 1989). The essence of TAM is that “*Perceived Usefulness*” and “*Ease of Use*” can predict computer acceptance behavior (Davis, 1989). It should be clarified, however, that the objective of the present study is not to apply the Technology Acceptance Model (TAM). We employ two TAM constructs (PU and EOU) in order to test the hypotheses derived from conventional retailing theory. These particular constructs are quite robust and can well operate independently of the TAM model, thereby serving the objectives of our study. Other researchers (e.g., Heijden, 2000), particularly in HCI, have also used instances of EOU and PU (or TAM in general) as convenient. Finally, the “*Entertainment*” construct used by Lastovicka (1983) was employed for testing Hypothesis 3, while “*Time*” (Hypothesis 4) is automatically measured by the system.

### Research hypotheses

The layout of conventional stores constitutes one of the most important factors influencing planned shopping behavior (Cobb & Hoyer, 1986; Seiders, Berry, & Gresham, 2000). The common grid layout facilitates routine and planned shopping behavior, making it easy for consumers to identify and purchase their pre-selected products quickly (Ghosh, 1994; Levy & Weitz, 2001; Lewison, 1994; Mason et al., 1991). Extrapolating to the internet, Heijden (2000, p. 417) suggests that “the perceived usefulness in a website context is defined as the degree to which an individual believes that using the site will contribute to reaching a particular objective” (i.e., planned purchases in the case of the present study). Website design has the potential to influence planned shopping behavior (Seiders, Berry, & Gresham, 2000); Hypothesis 1, therefore, aims to test whether the grid, as it occurs in conventional retailing, is the most useful layout for supporting online planned shopping behavior.

**Hypothesis 1.** Consumers perceive the grid layout as more useful for conducting planned purchases than freeform or racetrack layouts.

Lohse and Spiller (1998, 1999) report that interface layout constitutes one of the most important factors influencing consumers’ perceived ease in using a Web site. Davis (1989, p. 320) defines ease of use as “the degree to which a person believes that using a particular system would be free of effort.” Layout affects consumers’ perceptions of convenience when they navigate within the conventional retail store, and should therefore be appropriately manipulated by retailers in order to make shopping easier for consumers (Needel, 1998). Mason et al. (1991), Lewison (1994), and Levy and Weitz (2001), state that the freeform layout pattern in conventional retailing cases is designed for customer convenience and allows customers to move in any direction within the store easily. To that end, Hypothesis 2 aims to test whether the freeform layout, as it occurs in conventional retailing, is the easiest to use in virtual retailing.

**Hypothesis 2.** Consumers perceive virtual stores using the freeform layout as easier to use than other stores employing the grid or the racetrack layouts.

“Store layout design is intended to make shopping enjoyable” (Vasquez & Bruce, 2002, pp. 203–204). The conventional retailer who adopts the racetrack layout creates an unusual and interesting shopping experience, thereby providing entertainment for its customers (Ghosh, 1994; Levy & Weitz, 2001; Lewison, 1994; Mason, Mayer, & Ezell, 1991). Extrapolating to the internet, O’Keefe et al. (2000) and Bruner and Kumar (2000) show that a web interface affects perceived entertainment during online activity. Hypothesis 3, therefore, aims to test whether the racetrack, as it occurs in conventional retailing, is also the most entertaining layout in virtual retailing.

**Hypothesis 3.** The racetrack layout offers more entertainment during shopping activity to customers.

According to Herrington and Capella (1995), decisions about conventional store layout impact on the amount of time that customers spend shopping. Other research findings in conventional retailing cases also indicate that store environment and layout design can affect the time consumers spend in the store (Donovan, Rossiter, Marcolyn, & Nesdale, 1994), and that the freeform layout increases the time that consumers are willing to spend in the store (Levy & Weitz, 2001; Lewison, 1994). Similarly, in a virtual context, according to Eroglu et al. (2001), store layout influences the length of time that customers spend within a website. Furthermore, Heijden (2000) and Li, Kuo, and Russel (1999) state that website characteristics determine the duration of a website visit. Based on the aforementioned research insights, Hypothesis 4 aims to test whether the freeform layout, as it occurs in conventional retailing, increases the time customers spend in a virtual retail store.

**Hypothesis 4.** Consumers spend more shopping time in the free-form layout.



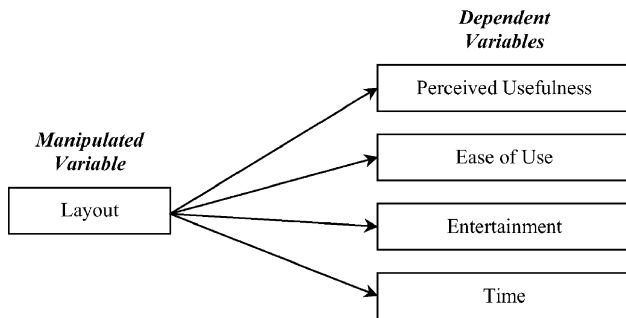


Fig. 4. The research model.

### Research methodology

Based on the research hypotheses presented above, two types of dependent variables were developed: those measured directly by the system (i.e., “Time”) and those measured via a questionnaire (i.e., “Perceived Usefulness,” “Ease of Use,” “Entertainment”).

Because the research calls for the testing of causal relationships among variables, and for the establishment of cause-and-effect relationships by eliminating competing explanations for observed findings, a laboratory experiment was selected (Churchill, 1999). It is depicted in Fig. 4.

### The process of transformation

Trying to make the setting as real as possible, the three conventional layout patterns (grid, racetrack, and freeform) were analyzed, designed, and transformed to a web-based business-to-consumer interface, following the design concepts discussed above (Figs. 1–3). A virtual store was developed in three alternative versions, each employing a different layout, following two basic precepts: (a) to transform the precise concepts and navigational rules governing each layout type in conventional retailing into corresponding layout patterns in the virtual store, and (b) to keep all other variables (e.g., background color, promotional banners, speed, product images, buttons, product display techniques, product prices, product assortment, etc.) the same, so that layout would be the only differentiating factor (i.e., manipulated variable).

In sum, we transformed the physical world into a virtual one, and tested this through a causal research approach where there were significant differences among the groups of subjects who visited the three different layouts. Fig. 5 shows the transformation of the three conventional retail store layout patterns to the corresponding virtual ones.

Despite the fact that web development does not constitute the research area of the present study, the development of this virtual store was a prerequisite in order to rigorously test the respective hypotheses. To that end, several methodological steps were taken towards the development of alternative virtual store layouts that simulate the relevant rules and concepts identified in conventional store layouts, while retaining distinct differences from each other.

The Object-Oriented Hypermedia Design Methodology (Schwabe & Rossi, 1995) was employed for the transformation process (Fig. 5). It includes the following steps:

- Domain analysis for each layout pattern:* Graph theory was used during the domain analysis phase as a design tool to depict all the alternative consumer navigation options within each layout.
- Identification of entities and procedures and development of entity-relationship diagrams for each layout pattern:* During this phase, all the entities and procedures included in each shopping interface (e.g., product category, product sub-category, aisle, corridor, selection of an aisle, check out, etc.) and the relationships between them were identified.
- Abstract interface design for each layout pattern:* User interfaces were designed, following the rules of each particular layout as provided through phases (a) and (b) above.
- Implementation of each type of layout:* The implementation of the virtual store was based on the 3-Tier Architecture Model (Falkou, Lytras, Pramataris, & Vrechopoulos, 1999). All three tiers (Client-tier, Application-server-tier, and Data-Server-Tier) were implemented using Microsoft’s technology and tools. Microsoft SQL Server 2000 was used to store product and customer information and process advanced queries. We also used best practice (e.g., buttons, text, menus, etc.) and HCI guidelines to produce a design. It should be noted, however, that the basic conditions for recreating the concept of each conventional layout on the web (i.e., keeping distinct differences between the three layouts and keeping all other factors which could potentially influence consumer behavior the same) were not affected by the HCI.

The generic navigation parameters of the resulting virtual layout patterns are described below:

- Grid:* Customers visiting the grid layout navigate through a hierarchical structure (i.e., product category ↔ product subcategory ↔ end-product) in order to reach their desired products.
- Freeform:* Customers visiting the freeform layout can reach their desired products at once, either through the use of a search engine or by selecting any of the items permanently displayed on every page of this version.
- Racetrack:* The racetrack layout forces customers to navigate through specific paths in order to reach their desired products. This is achieved by placing only two “corridors” on every web page. Customers, therefore, have to select one of the displayed corridors each time, in order to continue their navigation within the store.

### Experimental setting and sampling

The three different versions of the same virtual store were tested against real customers in a between-groups

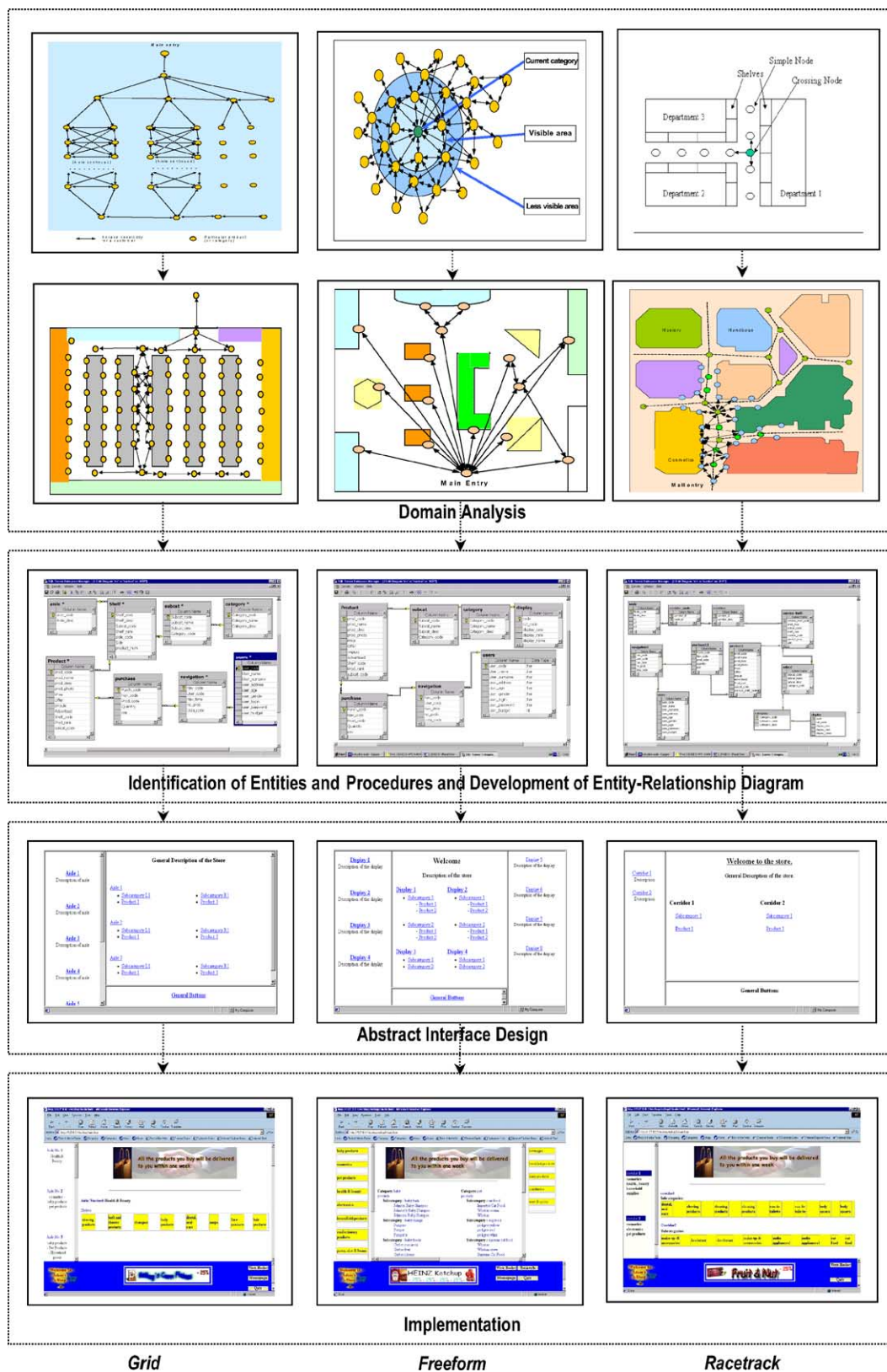


Fig. 5. The layout transformation methodology.

experiment in order to eliminate learning effects. The same experiment was run both in Greece and in the United Kingdom. It was unclear from the beginning whether or not these two samples should be treated as one (i.e., as drawn from the same population). Sixty subjects participated in each experiment (20 subjects per layout in each country; total 120 in both countries). Each subject was given a shopping budget of £20 or 12,000 GRD (the equivalent in Greek Drachmae) with which to make purchases within the experiment. Products “purchased” through the experiment were subsequently purchased by the authors at real stores (Sainsbury’s in the UK and Vasilopoulos in Greece) and physically delivered to the participants.

The lab-store offered mainly euro-brands (e.g., Coke, Heineken, Pringles, Tide, Johnnie Walker, etc.) in order to ensure compatibility of shopping preference among users from different countries. Own-label products were also included in the laboratory store. In addition, promotional activities and tools (e.g., promotional banners) were used within each type of layout.

The population from which the samples were drawn comprised Internet shoppers and experienced Internet users. The sampling frames were Brunel University (UK) and Athens University of Economics and Business (Greece). The sampling technique used was proportionate stratified sampling, with *occupation* as the key stratification variable. The resulting strata were: (a) academics, (b) students, (c) employees, (d) business executives (cooperating with the Universities), and (e) researchers. A stratified sample was used in order to ensure that all the important sub-populations of the sampling frame were represented in the sample. Decisions about sample size were made in a subjective manner, due to budget constraints. Questionnaires were used as data collection instruments, while the time spent within the store was recorded automatically through the system.

Finally, it should be noted that since consumers visiting grocery stores normally plan their purchases before entering stores (Cobb & Hoyer, 1986; Ghosh, 1994; Levy & Weitz, 2001; Lewison, 1994), subjects participating in the laboratory experiment were provided in advance with a blank shopping list, plus knowledge about what was available in the store, in order to plan their purchases beforehand.

## Analysis and results

Construct reliability was tested through the use of Cronbach’s alpha after an initial pilot study (Table 2). The pilot also served as a tool for revising the questionnaire and debugging the laboratory virtual store. The final experiment was run in the UK (Brunel University) and Greece (Athens University of Economics and Business) during June and July 2001.

### Combination of the two samples

In order to determine whether the two sets of scores (i.e., UK and Greece) were from the same or different populations, *t*-tests were used (Table 3). It was found that the samples were from the same population as there was no statistically significant difference between their observed means. Hence, for a combined sample, 40 observations per dependent variable and layout were used, instead of 20 (i.e., a total of 120 for the three layouts).

### Hypotheses testing

After combining the samples, it was found that the observed values for the dependent variables were from normal distributions (Table 4) and, thus, one-way between groups

Table 2  
Reliability analysis through the use of Cronbach’s alpha test for the dependent variables

Constructs	Construct items		Cronbach’s alpha
Perceived Usefulness	PU1	The store that I have just visited is useful for searching and buying products.	.9776
	PU2	The store that I have just visited improves my performance in product searching and buying.	
	PU3	The store that I have just visited enables me to search and buy products faster.	
	PU4	The store that I have just visited enhances my effectiveness in product searching and buying.	
	PU5	The store that I have just visited makes it easier to search for and purchase products.	
	PU6	The store that I have just visited increases my productivity in searching and purchasing products.	
Ease of Use	EOU1	The store that I have just visited is easy to use.	.9488
	EOU2	It is easy to become skilful at using the store I have just visited.	
	EOU3	Learning to operate the store I have just visited is easy.	
	EOU4	The store that I have just visited is flexible to interact with.	
	EOU5	My interaction with the store I have just visited is clear and understandable.	
	EOU6	It is easy to interact with the store I have just visited.	
Entertainment	ENT1	The store I have just visited was lots of fun to browse.	.9380
	ENT2	I thought that the store I have just visited was clever and quite entertaining.	
	ENT3	The store I have just visited was not just selling—it was entertaining me and I appreciated that.	
	ENT4	I liked the look and feel of the store I just visited.	

Table 3  
*t*-tests results for combining the two samples

Dependent variables	Layout	Normality tests (Shapiro Wilks)	<i>t</i>	Sig.	<i>p</i> -value
Perceived Usefulness	Grid	UK: .055; GR: .154	.215	.832	>.05
	Freeform	UK: .090; GR: .662	1.792	.078	>.05
	Racetrack	UK: .405; GR: .049	.527	.604	>.05
Ease of Use	Grid	UK: .684; GR: .264	.586	.565	>.05
	Freeform	UK: .061; GR: .402	.505	.620	>.05
	Racetrack	UK: .651; GR: .385	1.948	.066	>.05
Entertainment	Grid	UK: .251; GR: .492	−.223	.826	>.05
	Freeform	UK: .053; GR: .681	1.926	.064	>.05
	Racetrack	UK: .092; GR: .218	.144	.887	>.05
Time	Grid	UK: .184; GR: .664	.552	.588	>.05
	Freeform	UK: .339; GR: .553	−.406	.690	>.05
	Racetrack	UK: .051; GR: .906	.488	.631	>.05

Table 4  
 ANOVA parametric tests for testing the research hypotheses

Alternative hypotheses	Normality test (Shapiro Wilks)	<i>F</i>	Sig.	Finding	Means	Tukey HSD post hoc comparisons (i.e., order of effects)
Perceived Usefulness	.050	8.91	.000	Reject H0 at $\alpha = .005$	Grid: 4.0	Freeform $\gg$ grid
	.594				Freeform: 4.8	Grid > racetrack
	.051				Racetrack: 3.5	Freeform $\gg$ racetrack
Ease of Use	.061	17.782	.000	Reject H0 at $\alpha = .005$	Grid: 5.7	Grid $\gg$ freeform
	.057				Freeform: 5.0	Freeform $\gg$ racetrack
	.744				Racetrack: 4.2	Grid $\gg$ racetrack
Entertainment	.064	5.139	.007	Reject H0 at $\alpha = .01$	Grid: 3.6	Freeform $\gg$ grid
	.077				Freeform: 4.3	Grid > racetrack
	.049				Racetrack: 3.4	Freeform $\gg$ racetrack
Time	.171	5.118	.007	Reject H0 at $\alpha = .01$	Grid: 747.5	Racetrack > freeform
	.255				Freeform: 817.8	Racetrack $\gg$ grid
	.088				Racetrack: 971.3	Freeform > grid

Note.  $\gg$ : significant; >: not significant.

ANOVA parametric tests with post hoc comparisons could be used.

Interpreting the ANOVA results in Table 4, it was apparent that the layout significantly affects each of the corresponding dependent variables. More specifically:

- *Perceived Usefulness*: Subjects perceived the freeform layout as significantly more useful in finding their shopping list products within the store ( $p \leq .005$ ). There are significant differences between the freeform and the other two layouts, while there is no significant difference between the grid and the racetrack layout. Thus, Hypothesis 1 is not supported.
- *Ease of Use*: Subjects perceived the grid layout as significantly easier to use ( $p \leq .005$ ) than the other two. The test showed that there are significant differences between all the layouts; the racetrack was perceived as the least easy to use. Thus, Hypothesis 2 is not supported.
- *Entertainment*: Subjects found the freeform layout significantly more entertaining, by a small margin ( $p < .01$ ). Additionally, there is no significant difference between the grid and the racetrack layouts. Thus, Hypothesis 3 is not supported.

- *Time*: The layout significantly affects the length of time that customers spend shopping ( $p \leq .01$ ). However, the Tukey HSD test showed that significance lies only between the racetrack and grid layouts, with no significant difference between the racetrack and freeform layouts. Thus, the racetrack and freeform layouts engage subjects for longer, as would be expected from conventional retail theory. However, Hypothesis 4 is not supported.

Based on the aforementioned results, it is clear that none of the research hypotheses are confirmed. Thus, it becomes apparent that conventional retailing store layout theory, from which the research hypotheses were drawn, is not readily applicable in its present form within the context of online grocery retail and, therefore, that a relevant adaptation is required.

## Discussion

Our results suggest that customers visiting a virtual grocery store prefer a hierarchical/tree structure. This particular structure is provided only by the grid layout, which



was perceived as the easiest to use. This finding implies that the hierarchical/tree structure of the grid layout is the most effective means of navigating a virtual retail store, in line with HCI research findings (Lohse and Spiller, 1998; Nielsen, 1999). Customers' planned shopping behavior is also facilitated by being able to reach any place in the store directly, either from the home page or from any other place in the store. That capability is provided only by the freeform layout, which was perceived as the most useful layout for conducting planned purchases. This is no surprise, given the availability of the search facility within this layout. The freeform version was also perceived as the most entertaining layout. This finding could be probably explained by the fact that the changing range of products available in this particular layout contributed to an increase in customers' perceived entertainment. Furthermore, the race-track and freeform layouts engage subjects for longer, as would be expected from conventional retail theory. Finally, it should be clarified that this research adds to our understanding of *what* happens, rather than *why*. It is therefore out of the scope of the present study to discuss why conventional retailing theory should or should not work the same way using a computer-mediated interface as it does in the store environment.

In sum, while the layout of a virtual retail store on the web was found to affect consumer behavior, conventional retailing store layout theory, in terms of the dimensions investigated in this study, is not readily applicable in the context of virtual retailing.

#### *Previous research and the current findings*

According to O'Keefe et al. (2000, p. 613), "... the emergence of the consumer interface is producing review and re-evaluation of previous work in HCI." After an analysis of the results of the present study, this section focuses on relating its findings to HCI by investigating whether some of them confirm research insights from the specific usability and human factors literature.

Lohse and Spiller (1998) suggest that increasing the use of hyperlinks within an Internet retail store is the best way of effectively supporting customers in the accomplishment of their goals. Our study supports this, in that the "fully hyper-linked" environment implemented in the freeform layout assisted customers in their efforts to locate their shopping list products. Jarvenpaa and Todd (1997) state that the fact that consumers are looking for better-designed sites does not necessarily mean that they expect state-of-the-art technology but, rather, that they seem to be looking for thorough and "easy to use" sites that support the way they shop. This is confirmed in the present research, in the sense that the "dynamic product assortment" technique implemented within the freeform and race-track layouts was not as well received as the simple hierarchical structure implemented in the grid layout, which was found to provide greater "ease of use."

Stevenson, Bruner, and Kumar (2000) and Bruner and Kumar (2000) suggest that complexity has a negative effect on consumer attitudes towards a store. In the present study, the "complex" race-track layout fared less well in terms of the perceived "ease of use". Bruner and Kumar (2000) also found that the pages of relatively complex websites were perceived as more interesting and entertaining. This was also confirmed in the present study, in the sense that the "complex" freeform layout was evaluated as the most entertaining.

#### **Conclusions and managerial implications**

"The commercial benefits from improving the Web interface and experience presented to consumers are enormous" (O'Keefe et al., 2000, p. 613). Strategic exploitation of the present study's findings by virtual retailers should contribute to the development of more effective and consumer-friendly shopping interfaces. A mixed grid/freeform layout pattern constitutes an emerging layout for virtual retailing, as is evidenced by both our empirical work and the use of such layouts by Sainsbury's and Tesco in the UK. Moreover, it is clear that existing virtual grocery stores are struggling with various layouts that are not theoretically supported.

On the other hand, it is clear that virtual retailers should be careful when using principles and guidelines drawn from established conventional marketing and retailing. Many business failures have perhaps occurred either because conventional strategies and techniques were "copy-pasted" into the world of Internet retailing or because the lessons to be learnt from such "copy-pasting" exercises were ignored. Effective co-operation between different disciplines (Human Computer Interaction (HCI), marketing, retailing, etc.), therefore constitutes the key for designing effective virtual shopping environments.

#### *Limitations and future research directions*

The use of a laboratory instead of a field experiment is a basic limitation of this study. However, a "real shopping situation" was achieved through the provision of a real shopping budget.

Future research initiatives could focus on other sectors (e.g., banking). Such research may reveal that virtual store layout affects consumer buying behavior differently from sector to sector. A combined "grid/freeform" layout pattern, incorporating the advantages of both versions while avoiding their corresponding disadvantages, could be designed and developed. This emerging layout could be compared to other layout types (e.g., Gillenson, Sherrell, & Chen, 2000), replicating the present experiment and using either the same dependent variables used herein or new ones (e.g., sales, re-visits, promotion effectiveness, impulse purchases, etc.).

## References

- Baker, J., Grewal, D., & Levy, M. (1993). An experimental approach to making retail store environment decisions. *Journal of Retailing*, 68(4), 445–460.
- Baker, J., Grewal, D., & Parasuraman, A. (1994, Summer). The influence of store environment on quality inferences and store image. *Journal of the Academy of Marketing Science*, 22, 328–339.
- Baker, J., Parasuraman, A., Grewal, D., & Voss, G. B. (2002). The influence of multiple store environment cues on perceived merchandise value and store patronage intentions. *Journal of Marketing*, 66(2), 120–141.
- Bruner, G. C., II, & Kumar, A. (2000). Web commercials and advertising hierarchy-of-effects. *Journal of Advertising Research*, 40(1/2), 35–42.
- Burke, R. R. (2002). Technology and the customer interface: What consumers want in the physical and virtual store. *Journal of the Academy of Marketing Science*, 30(4), 411–432.
- Churchill, A. G., Jr. (1999). *Marketing research: Methodological foundation* (7th ed.). The Dryden Press.
- Cobb, C. J., & Hoyer, W. D. (1986). Planned versus unplanned purchase behaviour. *Journal of Retailing*, 62(4), 384–409.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly*, 13(2), 319–339.
- Donovan, R. J., Rossiter, J. R., Marcolyn, G., & Nesdale, A. (1994). Store atmosphere and purchasing behavior. *Journal of Retailing*, 70(3), 283–294.
- Erdem, O., Oumlil, B. A., & Tunculp, S. (1999). Consumer values and the importance of store attributes. *International Journal of Retail & Distribution Management*, 27(4), 137–144.
- Eroglu, S. A., Machleit, A. K., & Davis, L. M. (2001). Atmospheric qualities of online retailing: A conceptual model and implications. *Journal of Business Research*, 54(2), 177–184.
- Falkou, H., Lytras, G., Pramataris, K., Vrechopoulos, A. (1999). Putting the consumer on “top”: Traditional online products store. In J. Pries-Heje, C. Ciborra, K. Kautz, J. Valor, E. Christiaanse, D. Avison, & C. Heje (Eds.), *Proceedings of the 7th European Conference on Information Systems (ECIS)* (Vol. 1, pp. 142–156). Copenhagen, Denmark: Copenhagen Business School.
- Ghosh, A. (1994). *Retail management* (2nd ed.). New York: The Dryden Press.
- Gillenson, M. L., Sherrell, D. L., Chen, L. (2000). A taxonomy of web site traversal patterns and structures. In *Communications of the association for information systems* (Vol. 3, Article 17). Accessed at: <http://cais.isworld.org/articles/3-17/article.htm>.
- Grewal, D., & Baker, J. (1994). Do retail store environment cues affect consumer price perceptions? An empirical examination. *International Journal of Research in Marketing*, 11(2), 107–115.
- Heijden, H. V. D. (2000). The impact of perceived website characteristics on website traffic. In S. Klein, B. O’Keefe, J. Gricar, & M. Podlogar (Eds.), *Proceedings of the Bled Electronic Commerce Conference: The End of the Beginning, XIII* (Vol. 1, pp. 414–425). Kranj, Slovenia: Moderna organizacija.
- Herrington, D. J., & Capella, L. M. (1995). Shopper reactions to perceived time pressure. *International Journal of Retail & Distribution Management*, 23(12), 13–20.
- Jarvenpaa, S. L., & Todd, P. A. (1997). Consumer reactions to electronic shopping on the world wide web. *International Journal of Electronic Commerce*, 1(2), 59–88.
- Lastovicka, J. L. (1983). Convergent and discriminant validity of television commercial rating scales. *Journal of Advertising*, 12(2), 14–23.
- Levy, M., & Weitz, B. A. (2001). *Retailing management* (4th ed.). McGraw-Hill, IRWIN.
- Lewison, D. M. (1994). *Retailing* (5th ed.). New York, NY: Macmillan College Publishing Company.
- Li, H., Kuo, C., & Russel, M. G. (1999). The impact of perceived channel utilities, shopping orientations, and demographics on the consumer’s online buying behavior. *Journal of Computer-mediated Communication*, 5, 2. Accessed at: <http://www.ascusc.org/jcmc/vol5/issue2/haorong.html>.
- Lohse, L. G., & Spiller, P. (1998). Electronic shopping: How do customer interfaces produce sales on the internet. *Communications of the ACM*, 41(7), 81–87.
- Lohse, L. G., & Spiller, P. (1999). Internet retail store design: How the user interface influences traffic and sales. *Journal of Computer-Mediated Communication*, 5, 2. Accessed at: <http://www.ascusc.org/jcmc/vol5/issue2/lohse.htm>.
- Mason, B. J., Mayer, M. L., & Ezell, H. F. (1991). *Retailing* (4th ed.). Boston: IRWIN, Homewood.
- Merrilees, B., & Miller, D. (2001). Superstore interactivity: A new self-service paradigm of retail service. *International Journal of Retail & Distribution Management*, 29(8), 379–389.
- Needel, S. P. (1998). Understanding consumer response to category management through virtual reality. *Journal of Advertising Research*, 38(4), 61–67.
- Nielsen, J. (1999). User interface directions for the web. *Communications of the ACM*, 42(1), 65–72.
- O’Keefe, R. M., Cole, M., Chau, P. Y. K., Massey, A., Montoya-Weiss, M., & Perry, M. (2000). From the user interface to the consumer interface: Results from a global experiment. *International Journal of Human Computer Studies*, 53(4), 611–628.
- Schwabe, D., & Rossi, G. (1995). The object-oriented hypermedia design model. *Communications of the ACM*, 38(8), 45–46.
- Seiders, K., Berry, L. L., & Gresham, L. G. (2000). Attention, retailers! How convenient is your convenience strategy? *Sloan Management Review*, 41(3), 79–89.
- Simonson, I. (1999). The effect of product assortment on buyer preferences. *Journal of Retailing*, 75(3), 347–370.
- Siomkos, G. J., & Vrechopoulos, A. P. (2002). Strategic marketing planning for competitive advantage in electronic commerce. *International Journal of Services Technology Management*, 3(1), 22–38.
- Stevenson, J. C., Bruner, G. C., & Kumar, A. (2000). Webpage background and viewer attitudes. *Journal of Advertising Research*, 40(1/2), 29–34.
- Vasquez, D., & Bruce, M. (2002). Design management—The unexplored retail marketing competence. *International Journal of Retail & Distribution Management*, 30(4), 202–210.
- Vrechopoulos, A. P., Papamichail, G., & Doukidis, G. I. (2002). Identifying patterns in internet retail store layouts. In P. Pardalos & Tsitsirigos V. (Eds.), *Financial engineering, e-commerce and supply chain—Book series applied optimization* (Vol. 70, chap. 14). Kluwer Academic Publishers.