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New product ideation might be improved by identifying and applying certain well-defined schemes derived from an historical analysis of product-based trends, termed "templates." These templates might contribute to the understanding and prediction of new product emergence. The authors derive templates in a study that maps the evolution of product changes by adapting a set of intrinsic operations originally designed to uncover hidden logical patterns in technological inventions. They find that the majority of new product versions can be accounted for by as few as five templates. The authors define the five templates and show that they derive from six elementary (first principle) operators. A procedure for utilizing the dominant template, termed "Attribute Dependency," is outlined, followed by a report of two experiments examining its usefulness in the context of product ideation.

# TOWARD IDENTIFYING THE INVENTIVE TEMPLATES OF NEW PRODUCTS: A CHANNELED IDEATION APPROACH

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The invention of new products has traditionally involved methods that encourage the generation of large numbers of ideas. The notion that the rewards of generating a large number of ideas outweigh the costs can be traced back to early studies in the field (e.g. Marschak, Glennan and Summers 1967). In view of the fact that this process tends to be highly complex and unformalized (e.g. De bono 1992; Klein 1990; Woodman, Sawyer, and Griffin 1993), those involved in generating new ideas may seek ways to become more productive as they progress from one ideation task to another. Some may succeed in identifying patterns of invention that are common to different contexts (e.g. Boden 1992; Dasgupta 1994; Weisberg 1992) and apply them within a certain product category, or even try to apply them to other product categories. Individuals who adopt such a cognitive strategy may expect to gain an advantage over others who treat every task as new and unrelated to past ideation. However, even if they prove productive, the patterns are likely to be idiosyncratic and, quite often, not even verbally definable (Weisberg 1992). As such, they lack permanence and generalizability. The main thesis of this paper is that certain patterns are identifiable, objectively verifiable, widely applied, and learnable, and that these patterns, termed *templates,* can serve as a facilitative tool that channels the ideation process, enabling the individual to be more productive and focused.

Let us illustrate these notions with an example. Analysis of Domino's Pizza's promotion strategy offering a discount for any delivery exceeding a 30-minute time limit shows that the company created a dependency between two previously unrelated variables, namely price and delivery time. The dependency was created by introducing a step function between the two variables: Within the first 30 minutes following the order, the price remains constant and immediately thereafter, it is discounted. This specific dependency could be applied in other contexts as well. Similar discounts could be offered, for example, in supermarket or laundry

delivery services when a predetermined delivery time limit is exceeded. Thus, we can say that a replicable pattern has been identified.

## Templates as Product-Based Trends

We can now extend the notion of replicable pattern to the notion of template. Templates represent replicable patterns that are generalizable across variables and products. Let us exemplify this extension by illustrating how one of the five templates identified in the present study, namely, the Attribute Dependency Template, is derived. Note that in the Domino's Pizza example a replicable pattern is obtained by duplicating the dependency between the two specific independent variables (price and time) through a step function. A general rule that new product ideas can be generated by introducing a *dependency between two previously independent variables through a step function* is far more general than the mere duplication of a pattern as suggested in the cases of the supermarket or laundry delivery services. This template and its generalizability across products can be illustrated with an example drawn from a recent study by Andrews and Smith (1996): Hungry Jack syrup bottles are designed for microwave oven use. The bottle labels change color on reaching a certain temperature, thereby informing consumers that the syrup is ready. Although, at first glance, the analogy may appear remote, this example contains the key features of the same template: The two independent variables, in this case, are temperature and label color. A dependency is created by a step function between these two variables. Up to a critical temperature, the label color is not activated, and on reaching it, the color changes. The generalized form no longer involves the specific variables of the Pizza example, nor does it necessarily involve the same product (or service). Yet, it is identifiable and general across products and services and, thus, it is defined as a template.

Since the operation of templates involves manipulating product attributes rather than market parameters, they can be used in considering new market needs in currently

underdeveloped product markets. For instance, the aforementioned template might be applied to generate a new idea in pizza delivery services by creating a meaningful dependency between two different attributes, such as price and temperature. Accordingly, a company might offer a price discount if the temperature of the pizza falls below a predetermined level at the time of delivery.

The added value of the template approach is that it draws on the identification of similar structures in former product changes, providing a different angle and sometimes more accessible resource for ideation, compared to the information obtained from analysis of current market needs. For example, the idea of creating a dependency between pizza temperature and price may originate from market-based information (i.e. information derived from the current market environment, e.g. Griffin and Hauser 1993, such as that implied by research indicating that temperature at delivery is a crucial factor in the choice of pizza service). Alternatively, it may be derived from product-based information (i.e. information that is inferred from inspecting the internal dynamics of the product, such as the incidence of dependencies between variables among new food-delivery services). Although the price-temperature idea may evolve both from market-based information and/or product-based information, the template approach may be more accessible since it specifies a structured framework for obtaining such an idea.

The added value of product-based information is especially apparent in more complex ideation contexts such as in the following example. A new idea in the category of drinking glasses might be a glass with a dual insulation capability: When the temperature of the content is high the insulation is low; when the normal drinking temperature is reached, the insulation is high. The advantage of such a glass would be that the content would rapidly reach the optimal drinking temperature which would then be maintained for an extended period of time. Relying merely on market-based information that the two factors - rapid cooling and heat preservation - are important for consumers could, potentially, lead to such an idea. However, relying on product-

based information by adopting the Attribute Dependency template may be even more useful: The information about these relevant parameters and the desired dependencies is contained in changes in products overtime. Other examples of an Attribute Dependency in this category are a drinking glass with colored lower section to camouflage residual juices or extracts, and transparent at the top, the dependency between height and diameter as manifested in cone-shaped cups allowing compact storage (in stacks), or a glass with base wider than rim to reduce the danger of spilling when carried around. This information, and hence, the template, should be especially valuable when market-based information is less accessible or invalid.

Clearly, many important product inventions have been derived from market-based information, using a variety of marketing research methods. However, the value of these methods in offering a rich and exhaustive set of tools for ideation has been criticized (e.g. Petroski 1994). Durgee, O'Connor and Veryzer (1996) noted that many wants lie below the surface and that current product users are not able to express wants and needs for non-existing products. Referring to the common method of asking buyers to describe problems with current products (Crawford 1991), they noted that big leaps to new product ideas may not be uncovered when respondents describe problems in terms of current products.

One possible outcome of excessive reliance on market-based information is the disproportionate effort that is currently devoted to "me-too" products, namely products which mainly involve product line extensions, improvement of current products, and cost reduction (Wind and Mahajan 1997). In contrast, product-based information has been shown to be effective in various other decision making contexts (e.g. reverse engineering, Srinivasan, Lovejoy, and Beach 1997; and "product archaeology", Ulrich and Pearson 1993). It is our contention that such information will be similarly effective in the context of ideation.

## *Deriving and Formulating the Templates*

An approach for analyzing the dynamics of evolution of technological innovations was developed by Altschuler (1985). We examined it for suitability in the context of product evolution. Altschuler conducted a backward analysis of problem-solution relationships and succeeded in identifying about 200 common phenomenological patterns, which he termed "standards". Although Altschuler's approach was aimed at inventive problem solving of technological systems rather than inventing new products, it is conceptually consistent with the present template approach in the sense that it focuses on internal operations. In the present study, only those operations that are relevant to the context of products were examined and adapted.

The initial identification of templates in our study was obtained by mapping structural changes in the soap category. A preliminary condition for inferring templates is knowledge of the chronological development of products. Existing data on the evolution of soap-related products were used in describing the original product in each stage, and the transition to the new product in the following stage[1]. The commonalties identified in the transition between products were classified in relation to Altschuler's typology, and were considered candidate product templates. This procedure was then replicated for three other product classes, namely, hygiene products, bank accounts, and sneakers. In these mapping studies five major templates were revealed. In the following section, we formulate the template taxonomy. Several basic definitions required for the development of the template taxonomy are provided below.

### Definitions

The characteristics of a product can be divided into **components** (objects such as the legs or seat of a chair) and **attributes** (variables of the product such as the color or height). It should

[1] The description of the development of the soap related category is based on a research project conducted by Brand Genetics Inc. (Research Report No. 96-01) and is presented here by permission from the company.

be noted that at the stage of template construction we consider only attributes that consist of factual information. Abstractions and inferences (e.g. aesthetics, Chattopadhyay and Alba 1988) are considered only at a later stage.

In addition, a distinction is made between **internal** attributes and components which are under the manufacturer's control and **external** attributes and components which are not controllable by the manufacturer but are present in the neighboring environment of the product in its common usage. Thus, the legs and seat of a chair are internal components while color and height are internal attributes; floor and table are external components and the height and weight of the person sitting on the chair are external attributes. Since all these components and attributes belong to the product and its neighboring environment they are considered legitimate *product-based information.*

The relations between two given characteristics (either between two components or between two attributes) are defined by **links**. In the case of attributes the links are defined as dependency. In the case of links between components two requirements have to be met: (1) *Direct Influence*; a change in one component is directly responsible for changing parameters in the other, and (2) A*ssignment of Function*; the influence has been designated by the manufacturer.

The links between the seat and legs of a chair are illustrated in Figure 1. In this example, there are two links between the legs and the seat: Link 1, the legs support the seat; Link 2, the seat holds the legs in place. Note also that the seat has a buckling effect on the legs. However, the latter is not defined as a link because it does not comply with the second requirement (assignment of function).

The complete set of links along with the internal and external components defines the product **configuration** and its boundaries (see Figure 2). Note that the configuration depends upon both the product structure and its usage context.

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**INSERT FIGURES 1 AND 2 HERE**

## Templates as Macro Operators

The configuration of a product is like a "snap shot" of the product-based information. In order to create a new product, the dynamics of change have to be defined as well. Templates define systematic changes between an early configuration (i.e. previous product version) and the one that follows it (i.e. the next product version). The changes between configurations can be

expressed as combinations of elementary steps, termed **operators**. Figure 3 presents six elementary (first principle) operators, which underlie the construction of the templates.[2]

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## INSERT FIGURE 3 HERE

Transition from an existing product to a new idea can be accomplished by applying these fundamental operators in a defined sequence. These "macro" operators, when applied both to the internal and external attributes and components, constitute the template. Note that external attributes and components are drawn from *objectively measurable factual* information about the product and its immediate environment. While the template initially draws solely on product-based information, market-based information is subsequently examined to complete the formulation of the product idea. In the following, we define and describe the five templates identified in the mapping study. For ease of comprehension, all the examples analyzed pertain to the automobile category.

The first template (described earlier, see Domino's Pizza and glass examples), operates in the context of product *attributes*. Links, in this case, pertain to *dependencies between product attributes*. Thus, the Attribute Dependency Template is obtained by applying *inclusion and linking* operators sequentially.

For example, on April 1, 1995, as part of a promotion campaign, the Volkswagen Motor Company "announced" a new car model - the "Polo Harlequin" - featuring differently colored parts. The "announcement" was not actually intended by the company, and was inserted merely as an "April Fool's Day" joke. However, massive response by customers calling in to place ordersconvinced the manufacturer to go ahead and produce it. It seems that neither the

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[2] Note that these six operators are in fact three operators and their inverse counterparts.

customers nor the researchers could foresee the demand for such a car. The car became quite popular in Europe and the concept of differently colored parts has even been adopted since by some of VW's competitors.

The concept of Polo Harlequin is consistent with the Attribute Dependency Template and can be obtained by creating a dependency between color and specific location of a car's parts (e.g. door, roof). It is analogous to the already existing dependency in this category between color and climate: Lighter colors have long been used in warmer climates, to avoid overheating and paint damage.

Unlike the Attribute Dependency Template, which operates in the context of product attributes, the other four templates revealed in the mapping studies operate in the context of product components. They include the following templates: Component Control, Replacement, Displacement, and Division. The formulation, examples and their sequence of operators are described in Chart 1. Overall, the mapping studies conducted among several product classes (soaps, hygiene products, bank accounts, and sneakers) indicated that despite some variation, the five templates account for almost 70% of new product emergence[3].

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[3] The distribution of templates in the soap study (based on brand-template matching of 1508 facings appearing in two large department stores by two trained judges, who achieved 97% agreement, was as follows: Attribute Dependency – 43%, Component Control – 13%, Replacement – 1.5%, Displacement – 6%, and Division – 1.5%. Additional mapping studies were conducted on other product classes (hygiene products, bank accounts, and sneakers), following the same procedure as in the study of the soap category. They produced the same template typology and a similar order of proportions of template-matched product versions. In the three categories the explanation of templates ranged as follows: Attribute Dependency - 40-68%, Component Control - 10-30%, Replacement - (<1%)-19%, Displacement - 1-3%, and Division - 2-4%. These distributions indicate recurrence of templates both among tangible products and services used by segments that do not necessarily overlap.

**INSERT CHART 1 HERE**

## The Template Approach and Ideation Research

The above taxonomy of templates can be used to approach the ideation task from a perspective based upon product rather than market information. Such a perspective is particularly useful given the traditional view of ideation as "*ill-defined*" (Simon, 1979) or "ill-structured" (Tauber, 1972). The ill-defined nature of ideation stands in contrast to other important new product activities (such as screening, diffusion, and various marketing assessment tools, e.g. Narasimhan and Sen 1983, which are characterized as "well defined" because they lend themselves to specific definitions in terms of numerical variables and to well-defined solution plans. Most widely used ideation methods (e.g. brainstorming and Random Stimulation) do not transform the ill-defined nature of the problem into a defined and channeled process. Their validity has been questioned in a number of experimental

studies concerning creativity and effectiveness (e.g. Bouchard 1969; Diehl and Stroebe 1987, 1991; Weisberg 1992). The main conclusion from these studies is that such methods lead to an excess of ideas and analogies which actually obstruct the ideation process. It was found that the source of satisfaction from this kind of ideation sessions is the process of ideation itself rather than the quality of the ideas (note the "illusion of group productivity", Paulus et. al, 1993). In addition, Tauber (1972) has pointed out that the search for new ideas typically suffers from a lack of synchronization between the two different activities - screening (which is well-defined) versus ideation (which tends to be ill-defined).

Coping with the "ill-defined" nature of ideation tasks may be made easier by using an approach which is consistent with two principles. The first, originating in cognitive psychology, predicts that *restricting the scope of an issue enhances inventive productivity*. Perkins (1981) indicated that thinking within a frame of reference requires sensitivity to the rules of the game and that, by functioning within such a frame, one is better able to notice or recognize the unexpected. Finke, whose research focused on the impact of visual information (e.g. Finke and Pinker, 1981, 1982), noted:

> "...restricting the ways in which creative cognitions are interpreted encourages creative exploration and discovery and further reduces the likelihood that the person will fall back on conventional lines of thought. Restricting the categories, for example, forces people to think about conceptual implications in more atypical ways, which tends to promote creative discovery ... and can force one to consider novel interpretations of those concepts... (Finke, Ward, and Smith, 1992, p. 32)."

The second principle recommends the adoption of a structured ideation process which best mimics the thinking pattern that people really follow when engaged in inventive thinking. Introspective reports in experiments conducted by Finke, Ward and Smith (1992) indicated that subjects often search for emergent features in the forms (e.g. images and objects), then contemplate their functional properties, imagine themselves actually using these forms, and finally, mentally elaborate on the context in which the forms should be found. This sequence of events underlies the notion of *function follows form*. Accordingly, people are more likely to make creative discoveries when they analyze novel forms and then assess what benefits they may project rather than trying to create the optimal form solely on the basis of the desired benefits.

Compliance with these two principles should enhance the efficiency and productivity of inventive thinking. It transforms the ideation process from "ill-defined" to more "well-defined". Some techniques specifically tailored for ideation tasks, such as morphological analysis (cf. Urban and Hauser 1993; note also the HIT procedure, Tauber 1972), attempt to cope with the "ill-defined" nature of ideation by manipulating both market and product-based information.

Morphological analysis initiates the ideation process by referring to currently existing rather than imaginary product features. It calls for identifying the dimensions of the problem or the product (e.g., type of ignition in cars, packaging in food categories etc.), listing all possible combinations of dimensions, examining the feasibility of the alternatives, and selecting the best one. However, one drawback of this method relative to the template approach is that it does not define specific guidelines regarding which *dimensions* should be used and *how* they are to be combined. Furthermore, since the meaning of dimensions is broadly defined and could potentially lead to the generation of high order working matrices, a very large number of ideas can be generated. In the absence of a prescribed reduction mechanism, the selection process for the best ideas may be compromised (see the discussion of limitations in Tauber,1972).

In sum, the template approach integrates three major invention enabling perspectives. The first stems from the proposition that several identified templates underlying the internal dynamics of product evolution can predict new candidate products by providing guidelines for ideation. The second is the "restricted scope" principle, which is embodied in the template approach by channeling thinking along pre-defined inventive routes. The third perspective is the *function follows form* principle which is manifested in the sequence of first proposing new configurations of the product (which are template-based) and then, considering the benefits, aesthetic values, and other market parameters. The initial configuration and the consideration of consumer benefits, jointly form the product idea.

Structures resembling product templates that were developed and applied in other fields have been valued as creative (e.g. Koestler 1964). Creativity perception may be enhanced because these structures match certain *attractors,* namely, paths that the self organized mind tends to follow (Kelso 1997) and because they preserve the original level of complexity (i.e. no new attributes or components are introduced beyond those which exist in the product or in its

neighboring environment) while adding new utilities (Altschuler 1986). In particular, the perception of linking previously unlinked phenomena as a creative act was first reported by Koestler (1964). Koestler performed such linking within a multidimensional matrix of unlinked parameters regarding other phenomena. The Attribute Dependency Template is a reduction of his multidimensional matrix to a more simplified, two-dimensional structure, which is recurring in the context of new products. It is therefore expected that ideas matching thAttribute Dependency Template will be perceived as creative in the context of new product ideation.

The procedure for utilizing the dominant template – the Attribute Dependency Template - is outlined below, followed by a report of two experiments examining its usefulness.

## *THE ATTRIBUTE DEPENDENCY TEMPLATE: A PROCEDURAL FRAMEWORK*

### 1) Construct a Dependency Matrix

Following the identification of a product's internal and external attributes, a matrix of attributes is constructed, the columns listing internal attributes and the rows listing *both* internal attributes *and* external attributes. The task at this stage is to identify potential new dependencies between attributes appearing on the two axes.

Figure 4 shows a sub-matrix of a dependency matrix constructed for the case of drinking glasses, a category used in Experiment 2. The dependency matrix cell receives the value 0 if the attributes are independent (e.g. color vs. sugar concentration) and a non-zero value if the column variable depends on the row variable (e.g., capacity depends on height).

For illustrative purposes, assume that four cases of zero cells (i.e. cells that are initially independent) can be identified. These are denoted as (a) to (d) in this sub-matrix. One case (marked as 1) represents a natural dependency. For convenience, other zero cells are not marked although they too might be relevant.

**2) Introduce the Attribute Dependencies**

The Attribute Dependency procedure is performed at this stage by introducing a dependency between previously independent attributes. In terms of the dependency matrix this entails changing the value of a zero cell. For example, the color of the glass could be made dependent on the temperature of the content (case "a" in Figure 4). This dependency may be created by introducing a color change (e.g. from green to red) at a critical temperature. This task is best performed by individuals who belong to the operating environment or individuals with high level of macroenvironmental knowledge (Lehmann and Winer 1994) because they will be more efficient in acquiring new information and eliciting related knowledge (Alba and Hutchinson 1987; see detailed review in Andrews and Smith 1996).

**3) Obtain a Candidate New Idea**

The objective at this stage is to scan the potential benefits of the ideas following the "function follows form" principle. Consider the dependency created between color and temperature (case "a"). By examining the potential benefits, at least three product ideas may be generated. First, the threshold for color change could be made dependent on the risk of breakage due to overheating. The resulting idea may be a glass that changes color when it reaches a certain temperature in a microwave oven. A second idea may seek to maximize the benefit for the user of the glass. In this case, the purpose of the color change may be to avoid overheating the content of the glass. This might be particularly suitable in the case of use by children. Third, the

dependency may be applicable in a related product domain, for instance, a baby-bottle that changes color when the contents reach a certain temperature.

Treatment of the marked zero cells (b-d) of the dependency matrix in Figure 4 in a similar way to the above treatment of "case a" may produce additional new product ideas, such as a coned-shaped glass that could be easily inserted into the sand at the beach (by making the diameter of the glass proportional to height), or a glass with an insulation strip (by making the heat insulation of the glass dependent on its height).

The two experiments, reported below, were designed to examine whether training in the Attribute Dependency template improves outcomes compared to two widely used unstructured methods - Lateral Thinking and Random Stimulation (Experiment 1) and to a structured method – HIT (Experiment 2).

## EXPERIMENT 1

Overview The experiment was composed of two phases. In the first phase the idea generation setting was manipulated between groups: Participants were either trained in the template approach, trained in Lateral Thinking, or trained in Random Stimulation. Following training, they were asked to generate ideas either regarding baby ointment or mattresses. In the second phase, the ideas were rated by senior marketing professionals. All subjects participating in idea generation were university graduates or close to graduation. Their age range was 23-40 with a mean age of 30. Preliminary analysis showed that the groups did not significantly differ in age, education, or occupation.

Design and Procedure. 120 Subjects were randomly assigned into six groups generated by crossing the training factor (template, lateral thinking, random stimulation) with the product category factory (baby ointment, mattresses). Comprehension of the techniques was verified and explanation ceased only upon participants' indication that they could implement them in ideation. The template training involved about four hours including practice tasks. Training time in the competing methods was about two hours including practice tasks.

The efficacy of the template approach was assessed by comparing outcomes of the template training group (hereafter the TT groups) with those of the lateral thinking training (TL) and random stimulation training (TR) groups. The time framework for generating ideas (30 minutes) was identical in all three groups. Overall, the three groups generated 277 ideas, 132 for baby ointment and 145 for mattresses.

The ideas generated by the TT group for the ointment category included: an ointment that issues a specific odor upon urination by the baby; a series of ointments that differ in their concentration of active ingredients depending on the sensitivity of the baby's skin; and introduction of two types of ointment - one for day use and one for night use (higher consistency for increased protection at night by isolating the skin from the urine and lower consistency to allow for skin breathing during the day). Among the ideas generated by the TL group were: An ointment made of natural ingredients and an ointment with scent. The TR ideas included long lasting ointment and a colored (replacing the traditional white) ointment.

Three senior marketing professionals were invited to participate as judges in the evaluation procedure. All three professionals held MBA's, had a record of at least 10 years of experience in the marketing of consumer goods, and held high ranking marketing positions (at least vice president or equivalent level). These professionals were asked to rate the ideas on two scales, chosen in accordance with Finke's (1990) suggestion to assess ideas by their originality level and practical value. These scales are also compatible with the originality and usefulness measures recently adopted in the context of new product design by Dahl, Chattopadhyay, and Gorn (forthcoming). Accordingly, one scale measured originality with scale anchors (1) "Not original at all" and (7) "Very original". The second scale measured the overall value of the ideas. The judges were asked to indicate whether they would recommend investment in implementing the idea on a scale ranging from (1) "Not recommend at all" to (7) "Highly recommend". The judges were

blind to the identity of the group members, to one another, to the notion of templates, and to the purpose of the experiment.

**Results**

Table 1 displays the mean originality and value ratings for the three training groups. In the ointment category significant differences were obtained between the three groups for both the originality of the ideas ($F(2,129)=52.13$, $p<.0001$) and the value ratings ($F(2,129)=97.46$, $p<.0001$).

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## INSERT TABLE 1 HERE

Comparison between the TT group and the TL and TR groups combined indicated that ideas produced by the TT group were superior both in originality ($t(129)=10.10$, $p<.001$) and in value ($t(129)=13.85$, $p<.001$). Comparison between the TL and TR groups showed no significant differences in terms of originality ($t(129)=1.34$, $p>.15$) and value ($t(129)=1.25$, $p>.20$).

In planning the analysis it was recognized that unstructured techniques are geared to the production of a large numbof ideas varying widely in quality and value whereas structured methods are prescreened and more focused (Perkins 1981). Accordingly, the smallest number of ideas produced by the TT group was selected and compared with a matching number of the highest ranking ideas obtained in the TL and TR groups. The ideas were sorted in descending order of rating. Based on this procedure the top 20 ideas were selected from each group. The second panel of Table 1 summarizes the results of this analysis. Significant differences were obtained among the three groups both when originality was the dependent measure ($F(2,57)=50.50$, $p<.0001$) and when value served as the dependent measure ($F(2,57)=69.64$, $p<.0001$). The comparison between the TT group and groups TL and TR indicated the

superiority of the TT group ideas both in originality ($t(57)=10.04$, $p<.001$) and in value ($t(57)=11.79$, $p<.001$). No significant difference was obtained between TL and TR both in originality ($t(57)<1$, n.s.) and in value ($t(57)<1$, n.s.).

This pattern of results was replicated for the mattress category (Table 1). As in the ointment task, the analysis first focused on the raw ideas. Significant differences were observed among the three groups both when originality and when value were the dependent measures ($F(2,142)=45.94$, $p<.0001$ for originality, and $F(2,142)=147.82$, $p<.0001$ for value). Similarly, dominance of the TT group over the TL and TR groups was obtained both for originality ($t(142)=9.48$, $p<.001$) and for value ($t(142)=17.17$, $p<.001$). There was no significant difference between the two non-template training techniques ($t(142)=1.27$, $p>.20$ for originality and $t(142)<1$, n.s. for value).

The procedure comparing the best ideas was subsequently performed resulting in significant differences for the originality ratings ($F(2,57)=28.61$, $p<.0001$) and for the value ratings ($F(2,57)=140.18$, $p<.0001$). Similarly, dominance of the TT group over the TL and TR groups was obtained both for originality ($t(57)=7.47$, $p<.001$) and value ($t(57)=16.74$, $p<.001$). However, between the Lateral Thinking and Random Stimulation ideas there was no significant difference ($t(57)= 1.18$, $p>.20$ for originality and $t(57)<1$, n.s. for value)[4].

In addition to the advantage of the template approach as manifested both in the analysis of the total set of ideas and the "best ideas" note that the highest ranking idea was an outcome of the template training both in the ointment and the mattress categories.

## Discussion

[4] Examination of the ideas generated by all three groups both in Experiment 1 and in Experiment 2 indicated that templates-matched ideas were used almost exclusively by the template trained individuals. Because the division between the template training and the remaining groups also dichotomizes the use or non-use of the templates, it can be concluded that templates are learnable and that they lead to more productive ideation.

The comparison between template training and training in competing unstructured techniques demonstrates the added value of incorporating the template approach in ideation. It should be noted that a major component of the costs involved in utilizing the TT technique is the relatively longer training time required. However, the high ranking of the ideas generated by the TT group suggests a "self screening" effect. Moreover, the fact that the TT group generated fewer ideas suggests that the next step of new product (screening followed by concept testing) should require reduced resources and time.

The effect due to training technique in Experiment 1 may be confounded by the required training time that differs between the techniques and thus, difference in training time may account for the results. In addition, Experiment 1 did not use a group of individuals who were not trained at all prior to idea generation. Such group might serve as a benchmark for assessing the added value of training in templates.

Experiment 2 was devised to address these issues. The technique taught to the control group in Experiment 2 was HIT (Tauber 1972, presented above), which requires equivalent training time and is deemed to be the closest "rival" technique to the template approach. In addition, in Experiment 2 the template approach was compared with a "no-training" (hereafter NT) group.

## EXPERIMENT 2

Overview Experiment 2 used a different product category - drinking glasses. Like Experiment 1, this experiment was composed of two phases. In the first phase the idea generation setting was manipulated between groups by either training in the TT approach, training in the HIT technique, or not training at all. In the second phase, the ideas were rated by three senior marketing professionals.

Design and Procedure. One group consisted of 18 individuals who were specifically trained to use the Attribute Dependency Template (the TT group). The second group was composed of 19 individuals who were trained to apply the HIT procedure (the HIT group). The training in the TT and HIT groups lasted four hours, including practice tasks. The third group consisted of 18 individuals who received no training at all (the NT group). As in Experiment 1, the efficacy of the template approach was assessed by comparing outcomes of the TT group with those of the HIT and NT groups. The time framework for generating ideas (30 minutes) was the same in all three groups. Overall, the three groups generated a total of 82 ideas.

Among the ideas generated by applying the Attribute Dependency Template were: A drinking glass for babies with color varying according to the temperature of the milk (when the milk is ready for drinking the color of the glass changes from red to blue); a tea cup with varying insulation capabilities according to the temperature of the tea (when the tea is too hot the glass enables fast cooling off, and upon reaching an optimal drinking temperature, the glass maintains the desired heat for an extended period of time). Among the outcome ideas generated by applying HIT were a glass that is purchased with a ready mixture of coffee and milk, a glass that automatically cools the fluid content when it is poured in, and a glass that glows in the dark for night feeding. The NT group generated ideas that included glasses that have exotic shapes, and a unique combination of colors for a set.

Three senior marketing professionals were invited to participate as judges in the evaluation procedure. Two of the judges were owners of marketing consulting agencies and one was a senior product manager. All three judges (who did not participate in experiment 1) had at least 7 years of experience in marketing positions. The evaluation procedure and scales were identical to those used in Experiment 1.

## Results

In analyzing the total set of ideas a significant difference was obtained between the three groups for both the originality of ideas ($F(2,79)=7.5$, $p<.001$) and their value ratings ($F(2,79)=29.8$, $p<.0001$). The results are presented in Table 2.

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**INSERT TABLE 2 HERE**

Comparison between the TT group and the combination of groups HIT and NT indicated that the TT group produced superior ideas both in originality ($t(79)=3.3$, $p<.005$) and in value ($t(79)=7.6$, $p<.001$). A comparison between the HIT and NT groups showed no advantage in terms of originality ($t(79)=1.1$, n.s.) or value ($t(79)<1$, n.s.).

Since Tauber's (1972) HIT does not confine the number of ideas, the more stringent analysis performed in Experiment 1 focusing only on the better ideas was repeated in Experiment 2. Accordingly, the ideas were sorted in descending order of rating and the top 17 ideas were selected from each group, matching the lowest number of ideas generated by the TT and NT groups. The results are presented in the second panel of Table 2. Significant differences were obtained among the three groups for originality ($F(2,48)=5.44$, $p<.001$) and value ($F(2,48)=32.3$, $p<.0001$). The comparison between the TT and groups HIT and NT combined indicated that the TT

group ideas dominated both in originality ($t(48)=3.2$, $p<.005$) and in value ($t(48)=7.6$, $p<.001$). HIT training outperformed no training at all in value ($t(48)=2.78$, $p<.01$) although not in originality ($t(48)=$ ($t(48)<1$, n.s.). In addition to the observed superiority of the TT approach both in the analysis of the total set of ideas and the "best ideas", the highest ranking idea was also "template-based".

## CONCLUSIONS AND IMPLICATIONS

The advantages of the template approach lie both in its consistency with related theories on ideation and in its practical usefulness. On the theoretical level, the templates are obtained by analyzing the in the evolutionary process of successful products at their mature stage and applying them in non-mature situations. This process is analogous to "stepping back" in time. By learning the regularities of product evolution through their *internal dynamics* the uncertainty associated with innovative ideas is reduced.

The template taxonomy represents a step toward modeling the dynamics of product ideation. If the parameters of such a model are based on product-based trends, the templates may have the capacity to facilitate the generation of new ideas with limited external information (e.g., consumer needs). In addition, the template approach removes thought barriers that might hinder ideation when traditional methods are utilized. Consider, for example, the car radio with its antenna removed. On first examination this situation would appear inconsistent and unrealistic. It provides no immediate cues as to how to resolve the inconsistency other than reinstating the antenna. The template scheme opens up routes for taking advantage of and resolving such inconsistencies.

With regard to its practical usefulness, several key advantages are worth noting. First, as demonstrated in the mapping studies, the majority of product versions can be described by as few as five templates. Furthermore, analysis within each of the categories supported the template framework. Second, the learning of the procedure facilitates common understanding regarding how to cope with the creativity task. Third, the template approach has a technological advantage in that the ideation task begins with existing (and therefore available) products.

With regard to generalizability, two important issues need to be taken into account. First, whereas the majority of products lend themselves to natural decomposition into

components and assignment of functions, others do not. This does not preclude the use of the template approach but it requires consideration of other assumptions that are specific to the product and its environment. Second, due to the simplicity and the prescribed method sequence, individuals from heterogeneous backgrounds (e.g. different product lines, departments, etc.) can apply the template approach and share a "common language of design" (Mahajan, Rao, and Srivastava, 1994; Wagner and Hayashi, 1994).

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# FIGURES, TABLES, AND CHARTS

Figure 1 : Link 1 - legs support the seat and hold it at the desired height. Link 2 - the sholds the legs in place.

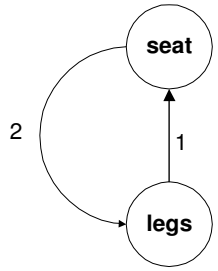



Figure 2: The configuration of an ordinary chair (oriented graph)

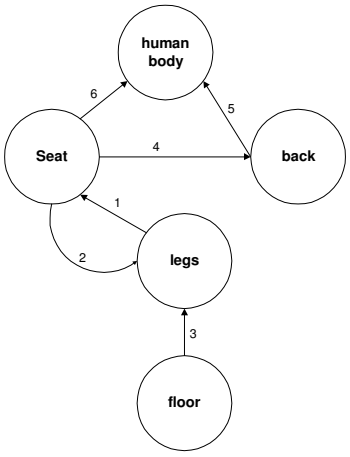


Figure 3: The Operators Underlying the Templates

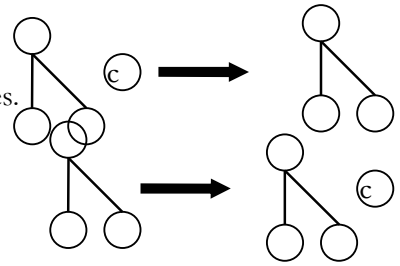
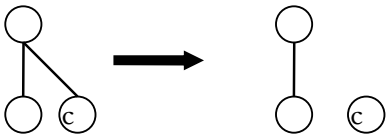
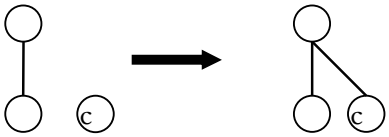
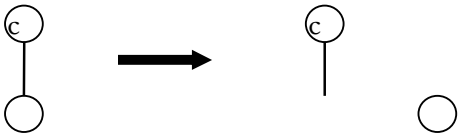
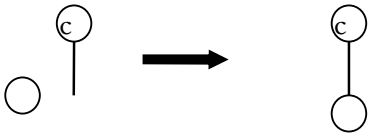
| Operator | Definition | Illustration |
|---|---|---|
| **1) Exclusion** | The exclusion operator removes an **unlinked** component from the configuration boundaries. |  |
| **2) Inclusion** | The inclusion operator introduces an **external** component into the configuration boundaries |  |
| **3) Unlinking** | An Unlinking operator eliminates a link. | |
| **4) Linking** | A linking operator connects two unlinked components or attributes. |  |
| **5) Splitting** | A splitting operator removes an **internal component** from the link. The link maintains the original functions. |  |
| **6) Joining** | A joining operator adds a (new) component to a dangling link |  |

Figure 4: Dependency sub-matrix for the case of a drinking glass.

| | Height of glass | Diameter | Color | Heat Conductivity | ..... |
|---|---|---|---|---|---|
| Thickness of base | 1 | | | | |
| Height of glass | | b | | c | |
| Temperature | | | a | | |
| % Sugar | | | d | | |
| .... | | | | | |

# Table 1: Experiment 1: Mean Originality and Value Ratings

| | Originality | | | Value | | |
|---|---|---|---|---|---|---|
| | **TT** Trained in Templates | **TL** Trained in Lateral Thinking | **TR** Trained in Random Stimulation | **TT** Trained in Templates | **TL** Trained in Lateral Thinking | **TR** Trained in Random Stimulation |
| **Raw Ideas** | | | | | | |
| **Ointment** | 5.47[1] | 3.57 | 3.36 | 5.97[1] | 3.09 | 2.82 |
| | (0.31) | (0.82) | (0.93) | (0.43) | (0.93) | (0.97) |
| **Mattress** | 5.83[1] | 3.47 | 3.22 | 5.79[1] | 2.71 | 2.64 |
| | (0.50) | (1.19) | (0.51) | (0.42) | (0.75) | (0.83) |
| **Best Ideas** | | | | | | |
| **Ointment** | 5.47[1] | 4.27 | 4.22 | 5.97[1] | 3.75 | 3.68 |
| | (0.31) | (0.45) | (0.55) | (0.43) | (0.76) | (0.83) |
| **Mattress** | 5.83[1] | 4.86 | 4.66 | 5.79[1] | 3.27 | 3.21 |
| | (0.50) | (0.55) | (0.51) | (0.42) | (0.55) | (0.67) |

Note:

[1] Represents significance (at least at p<.05 level) in the contrast between TT and the combined TL and TR groups.

## Table 2: Experiment 2: Mean Originality and Value Ratings

| | Originality | | | Value | | |
|---|---|---|---|---|---|---|
| | **TT** Trained in Templates | **HIT** Trained in HIT procedure | **NT** No training at all | **TT** Trained in Templates | **HIT** Trained in HIT procedure | **NT** No training at all |
| **Raw Ideas** | | | | | | |
| **Glass** | 5.20[1] | 3.83 | 4.15 | 4.82[1] | 2.99 | 2.91 |
| | (1.02) | (1.35) | (1.15) | (0.90) | (0.99) | (0.36) |
| **Best Ideas** | | | | | | |
| **Glass** | 5.20[1] | 3.94 | 4.15 | 4.82[1] | 3.59[2] | 2.91 |
| | (1.02) | (1.48) | (1.15) | (0.90) | (0.65) | (0.36) |

Note:

[1] Represents significance (at least at $p<.05$ level) in the contrast between TT and the combined HIT and NT groups.

[2] Represents significance (at least at $p<.05$ level) in the contrast between HIT and NT.

# Chart 1: The Other Four Revealed Templates

| Template | Description | Example | Sequence of Operators |
|---|---|---|---|
| **Component Control** | The template involves the creation of a *link* in the form of control of one internal component over another internal or external component. | A new electronic device connecting the battery of a car to the car body in order to inhibit corrosion and rust. The control is obtained by providing an excess of electrons to the cathode, thus enabling regulation of the electrostatic charge, since positive charge hinders electrochemical corrosion. | The Component Control Template is obtained by applying *inclusion and linking* operators, sequentially. |
| *Replacement* | Application of this template involves the *removal* of an *essential* internal component from the configuration while *maintaining* the link between the removed component and the remaining components. This operation creates a temporarily inconsistent abstract structure. Because of the dangling link, the operation is completed only when the missing component is replaced by another *already existing* component: *The replacement has to be an external component which can perform a function similar to that provided by the one removed.* | Consider a car radio. The internal component, in this case, the car antenna, is removed but its associated intrinsic function (reception of broadcast waves) is maintained. The resultant intermediate configuration is a necessary step in the replacement procedure even though it represents an incomplete product structure. The unsaturated function can be fulfilled by a component that is external to the car radio, in this case a defroster. Finally, the external component is incorporated by applying the joining operator, and the configuration of a new product is obtained -- a car radio that does not require an external antenna. | The replacement template involves the sequential application of the *splitting, excluding, including, and joining* operators. |

| | | | |
|---|---|---|---|
| **Displacement** | An essential internal component is removed from the configuration. However, in contrast to the Replacement Template, *its associated link is removed as well.* In this case, a new idea for the product has to be based on a new appeal, one that the former product did not provide. | An example of the Displacement template is excluding the car roof *and* its function and the new product is a convertible car[8]. | The Displacement Template involves the sequential application of the s*plitting, excluding,* and *unlinking* operators. |
| *Division* | Splitting one component into several components which either contribute individually to the accomplishment of its function, or become responsible for differential sub-functions. | Dividing a shock absorbing system into a four-way suspension to improve smooth driving and balance. | The Division Template involves the sequential application of the *splitting* and *linking* operators. |

[8] Some convertible cars have a folding roof whereas in others the roof is attachable but not an integral part of the car. The latter is a case of displacement