The Effectiveness of Case-Based Reasoning:

An Application in Sales Promotions

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ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2003-053-MKT
Publication	June 2003
Number of pages	60
Email address corresponding author	n.althuizen@fbk.eur.nl
Address	Erasmus Research Institute of Management (ERIM) Rotterdam School of Management / Faculteit Bedrijfskunde Rotterdam School of Economics / Faculteit Economische Wetenschappen Erasmus Universiteit Rotterdam P.O. Box 1738 3000 DR Rotterdam, The Netherlands Phone: +31 10 408 1182 Fax: +31 10 408 9640 Email: info@erim.eur.nl Internet: www.erim.eur.nl

Bibliographic data and classifications of all the ERIM reports are also available on the ERIM website:
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REPORT SERIES
RESEARCH IN MANAGEMENT

BIBLIOGRAPHIC DATA AND CLASSIFICATIONS		
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Library of Congress Classification (LCC)	5001-6182	Business
	5410-5417.5	Marketing
	HF 5438.5	Sales Promotion
Journal of Economic Literature (JEL)	M	Business Administration and Business Economics
	M 31 C 44	Marketing Statistical Decision Theory
	M 31 C 44	Marketing Decision Theory
European Business Schools Library Group (EBSLG)	85 A	Business General
	280 G 255 A	Managing the marketing function Decision theory (general)
	280 K	Marketing Science (quantitative analysis)
Gemeenschappelijke Onderwerpsontsluiting (GOO)		
Classification GOO	85.00	Bedrijfskunde, Organisatiekunde: algemeen
	85.40 85.03	Marketing Methoden en technieken, operations research
	85.40	Marketing
Keywords GOO	Bedrijfskunde / Bedrijfseconomie	
	Marketing / Besliskunde	
	DSS, Marketingmix, Verkooptechnieken,	
Free keywords	Marketing Management Support Systems; Weakly-Structured Decision Making; Case-Based Reasoning; Sales Promotions	

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June 2003

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ACKNOWLEDGEMENTS

The authors like to thank Ed van Eunen (Van Eunen Marketing), Rene Hendriks (Kees Verkade Promotional Partners) and Michiel van den Hoven (Unilever) for their help and John Rossiter and Marnik Dekimpe for their valuable comments on earlier drafts of this paper. Finally, we like to thank Empolis GmbH for providing us with an evaluation version of the CBR Works Professional software. This paper was supported by a grant from the Vereniging Trustfonds Erasmus Universiteit Rotterdam.

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ABSTRACT

This paper deals with Case-based Reasoning (CBR) as a support technology for sales promotion (SP) decisions. CBR-systems try to mimic analogical reasoning, a form of human reasoning that is likely to occur in weakly-structured problem solving, such as the design of sales promotions. In an empirical study, we find evidence that use of the CBR-system improves the quality of SP-campaign proposals. In terms of the creativity of the proposals, decision-makers who think highly divergent (i.e., who tend to generate many, and diverse ideas in response to a problem) benefit most from prolonged system usage. Creativity, in turn, is positively related to the (practical) usability of a proposal. These results suggest that the CBR-system is most effective when it is used as an idea-generation tool that *reinforces* the strength of divergent (creative) thinkers. A convergent thinking style, in which case the CBR-system has a compensating role, even has a negative impact on CBR-system usage. Increasing the decision-maker's personal belief in the usefulness of the system, e.g., by training or education, may help to alleviate this reluctance to use the CBR-system.

Keywords: Marketing Management Support Systems; Weakly-Structured Decision Making; Case-Based Reasoning; Sales Promotions

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1 INTRODUCTION

Problems come in a rich variety of sorts and sizes. This certainly applies to the domain of management. Managers face problems that vary considerably along dimensions like structuredness, availability of data and depth of knowledge. Simon (1973) roughly distinguished three types of problems: well-structured problems, semi-structured, and ill-structured problems. For well-structured problems all relevant variables and their underlying relationships are known, they come with complete data or information, are usually repetitive and routine, and can be solved with established solution techniques (Basadur, Ellspermann, and Evans 1994). For ill-structured problems it is difficult to define the exact nature, state and even the goal of the problem, they come with incomplete information and, as a consequence, there is no single correct solution. Such problems tend to be complex and non-routine (Mason and Mitroff 1973; Basadur et al. 1994). Semi-structured or weakly-structured problems contain both structured parts and ill-structured elements.

In operations management, for instance, problems like the scheduling of machine jobs are clearly defined, data are readily available and excellent models and techniques have been developed for optimizing the solution. Conversely, in management domains like strategy and human resource management problems often appear to be ill-structured. Managers in these domains therefore tend to rely more on “soft” knowledge, such as subjective judgments, hunches and intuition, than on “hard” models in order to solve a problem. Marketing problems - the area of management to which sales promotions, the application of this study, belong - fall somewhere in between. Consider, for example, a marketing problem like forecasting sales. In an empirical study, a combination of 50% managerial intuition and 50% model input was found to provide the most accurate solutions (Blattberg and Hoch 1990). This is indicative of the weak structure underlying the problem: parts of the problem are well structured and are amenable to modeling, while other aspects are “fuzzy” and difficult to understand and are best solved by subjective judgment and intuition.

Most management support system (MSS) researchers have argued that in order to be successful, the characteristics of the system should match with the characteristics of the problem situation for which it is developed (e.g., Mason and Mitroff 1973, Chakravarti, Mitchell and Staelin 1979; O’Keefe 1989; Todd and Benbasat 1992; Goodhue and Thompson 1995; Wierenga and Van Bruggen 1997, 2000). Hence, weakly-structured problems require other means of support than the well-structured problems in data-rich environments (Gorry and Scott Morton 1971).

However, so far, most MSS research has concentrated on supporting relatively well-structured problems, with an emphasis on model building and optimization (see Keen and Scott-Morton 1978; Sprague and Watson 1996) - which is also true for the domain of marketing (see Leeflang and Wittink 2000). Despite repetitive calls for more research on this issue (e.g., Mason and Mitroff 1973; Benbasat and Dexter 1982; Kletke, Mackay, Barr, and Jones 2001), management support systems for weakly-structured problems have not received that much attention (notable exceptions are Elam and Mead 1990; MacCrimmon and Wagner 1994; Massetti 1996; Marakas and Elam 1997).

Next to differences in the degree of structure, management decisions are made at different levels of importance, cf. strategic planning versus operational control (see Keen and Scott-Morton 1978). Decisions made at higher levels restrict the options at lower levels. If one starts off with making a bad high-level decision, then fine-tuning or optimizing decisions at lower levels can at best mitigate the harm already done. Merging with the wrong company, for instance, will have much larger negative financial consequences than a possible suboptimality in synchronizing the R&D departments. Given the high-stakes involved, we argue that improving managerial decision-making for high-level (marketing) problems (which tend to be weakly-structured) by means of a suitable support system provides an excellent opportunity for firms to enhance their performance.

With this study, we provide insight in the contribution of Case-Based Reasoning (CBR) as a technique to support managerial decision-making in weakly-structured domains. The basic questions that we address are: 1) does the use of a CBR-system improve decision quality, and 2) under which conditions is CBR-system usage most effective, i.e. for which type of decision-makers? In particular, we are interested in the question whether CBR-system usage is most beneficial for decision-makers who are compensated for their problem-solving weaknesses or for those whose strengths are reinforced. This question refers to the reinforcement versus compensation discussion in the MSS literature, to which we return later.

As mentioned, we conducted our empirical study in the domain of marketing. More specifically, we focus on the design of sales promotion (SP) campaigns. Sales promotions are direct inducements to buy a product or service (Rossiter and Percy 1997). Basically, the aim of putting sales promotion techniques, like price discounts, free samples, premiums and contests, into action, is to generate immediate increase in sales.

An example of a successful SP-campaign is a campaign organized by Heineken for its Amstel beer brand, in connection with the European Championship Soccer 2000. Besides increasing sales, the goals of the campaign were to achieve a “maximum correlation with the brand values”, to increase awareness of Amstel as being a “professional sponsor” of the tournament and to have “high visibility at the store level”. Consumers that purchased a crate of Amstel beer during the promotion period received a soccer table - which was mounted on the crate - as a premium. This “must have” gadget endorsed Amstel’s creative brand perception, and resulted in high brand awareness, penetration and increase of sales (source: EFSP Awards 2001). When designing a SP-campaign, the decision-maker usually disposes of a large problem space (many different solutions are possible) and creativity plays an important role.

Within the design of SP-campaigns, one can distinguish two decision levels: 1) choosing the main theme, content and SP-technique (*weakly-structured, higher-level decisions*), and 2) deciding within the context of this design upon the levels of the decision variables such as price, promotion budget and running time (*well-structured, lower-level decisions*). Existing support systems focus mainly on supporting the lower-level, relatively well-structured SP-decisions. To give an example, the well-known SCAN*PRO model (Wittink, Addona, Hawkes, and Porter 1988) concentrates on *price-promotion* decisions, such as decisions about the optimal depth, frequency and timing of price discounts. Obviously, once a manager has decided to use a price discount, it is important to determine the optimal discount level. But then again, maybe the manager should not have chosen a price-promotion in the first place. In this study, we focus on the higher-level, weakly-structured sales promotion design decisions. We use case-based reasoning as the decision support technology for these decisions.

This paper is organized as follows. First, we will describe case-based reasoning and discuss its potential for improving decision quality. Next, based on the existing literature, we develop a conceptual framework from which we derive hypotheses regarding the conditions under which the combination of the system and the decision-maker will be most effective. After describing the methodology, we present the empirical data and discuss the key results of this study. Finally, we address the managerial implications, outline the limitations of the study and suggest avenues for further research.

2 CASE-BASED REASONING

2.1 The Case-Based Reasoning Approach

Case-based reasoning (CBR) originated from the field of artificial intelligence. It attempts to mimic a type of human reasoning that occurs quite frequently in day-to-day (managerial) problem solving, namely reasoning by analogy (Riesbeck and Schank 1989; Kolodner 1993; Aamodt and Plaza 1994). CBR concerns the use of past experiences, so-called previous "cases", in order to interpret or solve the present problem, that is, the new "case" (Riesbeck and Schank 1989; Kolodner 1993). In brief, the CBR approach can be described as follows (see figure 1). The CBR-system contains a knowledge base filled with previous cases, called the "case base", and uses a similarity calculation to *retrieve* and rank stored cases that are similar to the new case, as specified by the user (Riesbeck and Schank 1989; Kolodner 1993; Aamodt and Plaza 1994). Subsequently, knowledge from the retrieved cases can be *reused* and *revised* to fit the requirements of the new case and finally the solved case can be *retained* in the system to aid future problem solving (Aamodt and Plaza 1994).

Insert Figure 1 about here

Basically, there are two types of case-based reasoning: 1) interpretive CBR and 2) problem solving CBR. Interpretive CBR involves reusing previous cases for classification tasks, such as diagnosis, evaluation and prediction - applications can be found in, for example, medical diagnosis and helpdesk situations (i.e., symptom-based diagnosis). Using CBR for problem solving, on the other hand, involves reusing and adapting solutions of past, similar problems in order to solve new problems. Typical applications are design problems (e.g., in architecture) or planning problems (for an elaborate discussion and specific applications, see Riesbeck and Schank 1989; Kolodner 1993; Althoff, Auriol, Barletta and Manago 1995; Leake 1996; Wierenga and Van Bruggen 2000; Marling, Sqalli, Rissland, Munoz, and Aha 2002).

Design problems, such as the design of SP-campaigns, are typically constraint problems for which the problem solver has to produce “a concrete artifact that satisfies the constraints” (Kolodner 1993). However, due to the usual underspecification of the problem, hence the term “weakly-structured”, multiple solutions are possible (Kolodner 1993). To help find a good solution, it can be useful to retrieve old cases that were constructed with similar constraints (Kolodner 1993). In fact, it is common practice for sales promotion practitioners to start digging into their mental library for examples of successful (or unsuccessful) previous campaigns in similar situations when designing a new campaign.

This procedure does not guarantee that one comes up with the best solution possible, but this is true for any type of heuristic problem-solving that is applied to weakly-structured problems. We believe that CBR-systems can enhance decision quality for weakly-structured problems, in two ways. First, by retrieving similar previous cases, useful knowledge contained in these cases can be readily transferred to develop an efficient and usable solution for the problem at hand (reasoning by analogy). Secondly, providing the decision-maker with previous examples may trigger the generation of novel ideas and enhance the creativity of the solution. These enhancement processes are discussed next.

2.2 Contribution of CBR to Efficiency

Reasoning by analogy[1] is referring back to past problem-solving experiences when encountering a new problem situation and using the solutions of previous, similar problems (i.e., the base) to solve the problem at hand (i.e., the target). The best-matching previous case is taken as the

[1] More formally, an analogy can be written as: A is to B as C is to D. Basically, solving problems by analogical reasoning is finding a solution for a new problem situation (C), by retrieving similar problem situations (A) from memory, and modify the old solutions (B) to develop a new solution (D) (Liang 1993).

ballpark solution. If necessary, the ballpark solution is adapted to resolve specific differences between the old and the current problem situation (Riesbeck and Schank 1989; Kolodner 1993; Van Bruggen and Wierenga 2001). Drawing an analogy thus involves mapping and transferring existing knowledge, i.e. relevant attributes and relationships, from the base domain to the target domain (Dahl and Moreau 2002).

To give an example, suppose a manager wants to launch a product in a foreign country by using a SP-campaign. For the introduction of the product in the home country, the company also used a SP-campaign that was quite successful. Now, the manager could decide just to take the campaign that was used for the home market as a ballpark solution and slightly adapt it to account for the cultural differences between the home and the foreign market, e.g. change the language of the promotional message.

By capitalizing on analogies with previous problems, a CBR-system can help to find a good solution in a very efficient way, due to its ability to put into action the soft, qualitative knowledge that is written down in cases. As Riesbeck and Schank (1989) state: "humans expert are not systems of rules, they are libraries of experiences". CBR-systems constitute such libraries of experiences, from which knowledge can be efficiently reused (see Fowler 2000). Although efficient and useful, the analogy in the previous example is not likely to be perceived as creative.

2.3 Contribution of CBR to Creativity

CBR-systems can also be an effective tool to enhance the creativity of the managerial output. Analogical reasoning is often thought to underlie creativity (Koestler 1964; Boden 1994; Dahl and Moreau 2002). Here, we have to make a distinction between near (or intra-domain) analogies and far (or inter-domain) analogies (see Bonnardel 2000, Dahl and Moreau 2002). Near analogies are drawn from base domains that have many properties in common with the target domain (e.g., SP-campaigns in the home country and a "new" SP-campaign in a foreign country). They tend to be perceived as less creative than far analogies that are drawn from very distant domains (e.g., using poetry as an inspiration for a new SP-campaign).

An explanation for this is that the amount of cognitive effort that is required to bridge the conceptual distance between the base domain and the target is larger when the domains are further from each other (Dahl and Moreau 2002). That is, the problem-solver has to make a “mental leap” instead of a “mental hop”. When drawing far analogies one cannot easily transfer (knowledge) elements on a superficial level from the base domain to the target domain. As a result of the greater effort required to draw far analogies, they are likely to be perceived as less obvious, more novel and more creative than near analogies (Dahl and Moreau 2002).

Within the domain of sales promotions, we can also distinguish between near and far analogies. SP-campaigns within the domain of fast-moving consumer goods (FMCG) (e.g., coffee and margarine) are rather different than those for consumer durables (e.g., cars and computers). We can classify analogies between two FMCG-promotions as “near” analogies and analogies between a consumer durable promotion and a FMCG promotion as “far”. To the extent that the cases contained in the CBR-system represent different domains, previous cases may not only help the manager to make more efficiently use of existing knowledge (and prevent managers from “reinventing-the-wheel”), but may also stimulate creativity.

2.4 Matching CBR-system and Decision-maker: Reinforce or Compensate?

Concerning the conditions under which CBR-system usage will be most successful, we refer to the ongoing debate in the MSS literature about the match between manager and support system (see Zmud 1979; Benbasat and Dexter 1982; Huber 1983, Wierenga and Van Bruggen 2000). This debate has focused predominantly on the fit between the type of support system and the decision-maker's cognitive style, particularly analytical versus heuristic[2]. The important question is whether a CBR-system is most helpful for decision-makers whose predominant thinking style is reinforced or for those decision-makers who are compensated for having a different style. Reflecting on the cognitive style debate, arguments on both sides have been made (see Mason and Mitroff 1973; De Waele 1978; Zmud 1979; Chakravarti et al. 1979; Huber 1983; Hunt, Krzystofiak, Meindl and Yousry 1989; O' Keefe 1989; Wierenga, Van Bruggen and Staelin 1999). With respect to the *adoption and use* of support systems - which is a necessary but not a sufficient condition for the success of MSS (Wierenga et al. 1999) - a "reinforcement" strategy has proven to be most successful (Zinkhan, Joachimstaler and Kinnear 1987; O'Keefe and Pitt 1988; Van Bruggen et al. 1998). If support systems are designed only to complement the decision-makers cognitive style - thus forcing the use of an alternative cognitive style - it is likely to result in non-use or, if use is mandatory, in lower performance (De Waele 1978; Huber 1983).

However, regarding decision or *solution quality*, "compensated" decision-makers seem to benefit more from the use of an MSS than "reinforced" decision-makers (Benbasat and Dexter 1982, 1985; Van Bruggen, Smidts and Wierenga 1998). That is, when using an *analytical* management support system, the improvement in decision quality between aided and non-aided decision-makers was found to be larger for heuristic decision-makers than for their analytical counterparts[3].

Overall, it seems that decision-makers are more inclined to freely adopt and actually use a system that reinforces their dominant cognitive style. However, in terms of decision quality, decision-makers have most to gain from a system that compensates them for using an alternative cognitive style. Note that these findings apply to decision tasks that are well-

[2] "Analytical (or systematic, field independent) decision-makers reduce a problem to a core set of underlying relationships and direct all effort to detecting and manipulating the decision variables in order to find an optimal solution with respect to the objectives. Non-analytical (or heuristic, field dependent) decision-makers look for workable solutions to the total problem situation and search for analogies with familiar, solved problems" (adapted from Wierenga and Van Bruggen 2000).

[3] Nonetheless, in both conditions analytical decision-makers were still able to outperform heuristic decision-makers.

structured, which favors an analytical decision-making style. As Benbasat and Dexter (1982) suggested, in ill- or weakly-structured decision environments, high analytical decision-makers would no longer have a comparative advantage over low analytical or heuristic decision-makers.

Since we are interested the ability of CBR-systems to enhance the decision-maker's creativity, in the next section we describe and use the related, though distinct concept of *thinking styles*, which is commonly applied in the creativity literature (see, for example, Torrance 1966; Guilford 1967; Amabile 1983; Boden 1994; Sternberg, O'Hara, Lubart 1997). Nevertheless, for the adoption and usage of the CBR-system we follow the same line of reasoning as for cognitive style.

The sparse empirical evidence regarding solution quality, however, points in the direction of a reinforcement strategy, that is, using a creativity support system particularly seems to improve the performance of *creative* individuals (MacCrimmon and Wagner 1994). The reason for this could be that computers are better able to compensate decision-makers for their inconsistency and inaccuracy – which may inhibit finding an optimal solution to well-structured problems - than to compensate for the lack of flexibility and creativity on the part of the decision-maker (see Blattberg and Hoch 1990). The question "can computers be creative?" has not been answered unequivocally yet (see, for example, Boden 1991; Schank and Cleary 1995; Cohen 1999; Buchanan 2001).

3 THE EMPIRICAL STUDY

3.1 Conceptual Framework

The basic premise underlying this study and most other decision support system research is that providing decision-makers with a decision support tool results in better decision performance than without the use of such a decision aid. Several studies have indeed shown that the use of decision support systems can lead to, for instance, shorter decision time, higher decision confidence, and improved solution quality (see for a review, e.g., Money, Tromp and Wegner 1988; Sharda, Barr, and McDonnell 1988; Benbasat and Nault 1990; Webby and O'Connor 1994). Hence, we expect that:

H1: The use of a CBR-system improves the quality of the solution.

We are especially interested in the conditions under which CBR-system usage is most effective. Our conceptual framework of how CBR-system usage influences the solution of a weakly-structured, high-level SP-problem is inspired by the integrating framework of factors that influence the success of MSS (Wierenga et al. 1999) and the task-technology-fit theorem (Goodhue and Thompson 1995), which both assert that the success of MSS largely depends on the match between the characteristics of the system (i.e., the supply side) and the characteristics of the decision situation, including the decision task (or problem) and the characteristics of the decision-maker (i.e., the demand side). Furthermore, we incorporate an element of the technology acceptance model (TAM) (Davis 1989; Davis, Bagozzi and Warshaw 1989; Venkatesh and Davis 2000) to explain CBR-system usage, viz. perceived usefulness.

Basically, the decision situation consists of three elements: the decision-maker, the support system and the problem to be solved. In this study, we focus on the match between the CBR-system and the decision-maker (see Figure 2). Prior to engaging in the problem-solving process, we can characterize both the decision-maker and the CBR-system on a number of attributes[4] (e.g., the decision-maker's thinking style and the system's case-base size) that may directly influence *CBR-system usage, solution efficiency* and *solution quality*. Supposedly, at the interface of the two entities, viz. the decision-maker and the CBR-system, interaction takes place that eventually results in a solution for the problem.

Insert Figure 2 about here

The basic dependent variable in this study is CBR-system success. The success of management support systems can be measured by means of its *usage*, improved *efficiency*[5], and solution *quality* (see also Wierenga and Van Bruggen 2000). As shown in Figure 2, we focus on two measures of succes, that is, CBR-system usage and solution quality.

- *CBR-system Usage*, including *usage time* and the *perceived impact of using the CBR-system on the solution* (which is the subjective impact of the system on the solution as perceived by the decision-maker);
- *Solution Quality*, including the *creativity* and the *usability* of the solution (which relates to the objective impact of the system on the solution).

Note that in the creativity literature (e.g., Amabile 1983; Boden 1994), a "creative" solution is usually defined as one that is novel and useful. We measure both creativity and usability as components of solution quality, and assume that creativity is an antecedent of usability (see Figure 2). Next to CBR-system usage, which is assumed to be an independent variable for

[4] Since in our study all respondents use the same system there is no variation with respect to the characteristics of the CBR-system. Therefore, the dotted arrow in Figure 2 is beyond the scope of this study.
[5] We did not have sufficient information to draw conclusions on efficiency improvements as a result of CBR-system usage for developing a solution.

solution quality, we a identify a number of decision-maker characteristics that, one the one hand, may drive CBR-system usage and, on the other hand, may have a direct impact on solution quality (see Figure 2). We take the latter into account by including the decision-maker characteristics as control variables in the analyses regarding the effect of CBR-system usage on the solution. We include the following decision-maker characteristics (see Figure 2):

- *Thinking Styles (Convergent and Divergent)*
- *Perceived Usefulness of the CBR-system*
- *Motivation to Solve Challenging Problems*

3.2 CBR-system Usage

We hypothesize that the following decision-maker characteristics drive CBR-system usage - which is a necessary, but not a sufficient condition for CBR-system success - namely:

- *Thinking Styles (Convergent and Divergent)*
- *Perceived Usefulness of the CBR-system*

Thinking styles distinguish between *divergent* thinking and *convergent* thinking[6]. Divergent thinking is considered to be a vital trait for creative problem solving (Amabile 1983; Boden 1994; Sternberg, O'Hara, Lubart 1997). Decision-makers who think divergently are inclined to generate many alternative solutions in response to a problem, including unusual and creative ones (Sternberg and Lubart 1992; Baer 1993). Convergent thinkers, on the other hand, directly start to work towards a single correct solution. They tend to take the first solution that comes to mind and modify it until it fits the problem situation at hand (Sternberg and Lubart 1992).

[6] We regard divergent and convergent thinking as ideal traits, and not as mutually exclusive. In fact, it is often argued that an individual very frequently engages in much divergent production on the way to a convergent answer (e.g., Guilford 1967). An individual can, to a certain extent, be good at both divergent thinking and convergent thinking and hence produce an outcome that is both original (as result of a divergent thinking process) and meaningful (as a result of convergent thinking process) (Guilford 1968; Tardif and Sternberg 1988).

Next to the system's match with the preferred thinking style of the decision-maker, the decision-maker's attitude towards using an MSS will influence its usage. Therefore, we also take into account the *perceived usefulness of the CBR-system,* i.e. the extent to which the decision-maker believes that using the CBR-system will enhance his or her performance.

3.2.1 CBR-system Usage Time

According to the compensation/ reinforcement discussion earlier in this paper, we expect that decision-makers with a divergent thinking style will be more inclined to adopt and use the CBR-system than convergent thinkers, since we think that CBR-system matches with a divergent thinking style. That is, the system generates a number of examples or ideas - which reinforces the strength of a creative, divergent thinker - but does not provide clear-cut solutions or solution pathways, which would match with a convergent thinking style. Moreover, because convergent thinkers tend to work directly towards a solution, they are likely to take the first solution provided by the CBR-system as a ballpark solution and modify it until it fits all problem constraints, which results in lower CBR-system usage times. Divergent thinkers, on the other had, will look for alternatives provided by the system, resulting in higher usage times. Thus, we expect the following relationships between thinking styles and CBR-system usage time:

H2a: A divergent thinking style will have a positive effect on CBR-system usage time.

H2b: A convergent thinking style will have a negative effect on CBR-system usage time.

In line with the technology acceptance model (Davis 1989; Davis et al. 1989; Venkatesh and Davis 2000), which has been found to be consistent with much empirical research (see Venkatesh and Davis 2000), we expect that the perceived usefulness of the CBR-system will be a strong determinant of CBR-usage time. That is, if the decision-maker, even after a brief introduction, perceives the CBR-system as being instrumental or useful for coming up with a solution, then he or she will very likely continue and prolong CBR-system usage. In sum, we posit that:

H2c: The decision-maker's perceived usefulness of the CBR-system will have a positive effect on CBR-system usage time.

3.2.2 Perceived Impact of the CBR-system

Regarding the perceived impact of using the CBR-system, we expect a positive relationship with CBR-system usage time. That is, the longer the decision-maker has used the CBR-system, the more likely he or she will attribute a larger part of the final solution to the use of the CBR-system. However, irrespective of usage time, the perceived usefulness of the CBR-system may also directly influence the perceived impact of the system on the final solution. For example, if the decision-maker just copied the first solution provided by the system, then usage time will be rather low, though the perceived impact of system could still be very high. Thus:

H3a: CBR-system usage time will have a positive effect on the perceived impact of the CBR-system on the solution.

H3b: Perceived usefulness will have a positive effect on the perceived impact of the CBR-system on the solution, over and above the influence of CBR-system usage time.

3.3 The Solution

CBR-system variables. We are primarily interested in the question of how the solution will depend on the CBR-system related input in the decision-making process (see also Figure 2). We focus on the influence of:

- *CBR-system Usage Time*
- *Perceived Impact of the CBR-system*

Non-CBR-system Variables. The solution is furthermore assumed to depend on the following problem-solving properties of the decision-maker, which are included as control variables:

- *Thinking Styles (Convergent and Divergent)*
- *Motivation to Solve Challenging Problems*

The decision-maker's motivation to solve challenging problems is defined as the willingness to devote time and effort for solving complex, non-routine, non-trivial problems (Harter 1981), such as high-level, weakly-structured sales promotion problems in which creative elements play an important role. This motivation could have a direct impact on the outcome of the problem-solving process (see, for example, Amabile 1983; Sternberg and Lubart 1992), and is therefore included as a control variable.

We make an explicit distinction between the creativity and the usability of the solution, and argue that these components of the solution may have different antecedents. We will discuss the hypothesized relationships in the following sections.

3.3.1 Solution Creativity

Creativity is often argued to spring from the decision-maker's ability to think divergently, i.e. to generate many, diverse ideas in response to a problem (Guilford 1967; Sternberg and Lubart 1992). An important facet of divergent thinking is ideational fluency. Fluency is the person's ability to generate a large *number* of relevant responses to a certain problem or certain stimuli (Guilford 1967). Previous studies have shown that the ratio of good-quality ideas (i.e., original and valuable) to sheer number of ideas has been found to be constant and high (> 0.7) (see Rossiter and Lilien 1994). To put it differently: quantity breeds quality.

If one provides people with (computer-generated) examples, the fluency aspect of divergent thinking can be effectively enhanced. Several studies (e.g., MacCrimmon and Wagner 1994, Massetti 1996; Bonnardel 2000) have indeed demonstrated this effect. That is, respondents generated significantly more and novel ideas when they were given examples. Now, a CBR-system contains a knowledge base with cases that constitute examples of possible, past solutions and, hence, may trigger ideas about what can be done in the future.

Basically, we thus assert that providing computer-generated examples stimulates the innate fluency of the decision-maker, which in turn will positively influence the creativity of the output (see Wierenga and Van Bruggen 1998). The longer the decision-maker has used the CBR-system, the more cases or examples he or she will have consulted. The more cases the decision-maker has consulted, the larger the number of ideas generated and, eventually, the more creative the solution will be. Thus, we hypothesize that:

H4a: CBR-system usage time will have a positive effect on the creativity of the solution.

Consistent with the few empirical findings regarding the effectiveness of creativity support systems, we expect a reinforcement strategy to be most beneficial. The line of reasoning behind this is as follows. Divergent thinkers by definition generate more ideas in response to a problem than non-divergent thinkers, since they like to have multiple options to choose from. Hence, the CBR-system matches with a divergent thinking style by means of its ability to provide examples of possible solutions. Because providing examples, in turn, stimulates the innate fluency of the decision-maker, CBR-system usage *reinforces* the strength of divergent thinkers. Per example or case viewed, divergent thinkers will generate more ideas than non-divergent thinkers. Hence, we hypothesize that prolonged CBR-system usage will be particularly effective for divergent thinkers. In other words, we expect that the relationship between CBR-system usage time and solution creativity will be moderated by the divergent thinking style of the decision-maker:

H4b: The positive effect of CBR-system usage time on the creativity of the solution will be larger for decision-makers with a high divergent thinking style than for those who have a low divergent thinking style.

From the previous discussion it follows that a divergent thinking style can also have a direct impact on the creativity of the solution. Therefore, we include it as a control variable in our analyses and posit that:

H4c: A divergent thinking style of the decision-maker will have a positive effect on the creativity of the solution.

A second control variable is the decision-maker's motivation to solve challenging problems, which has often been identified as an important driver for creativity (see, for example, Amabile 1983; Sternberg and Lubart 1992). First of all, if the decision-maker is intrinsically motivated, i.e. he or she performs the task because it is fun, challenging and evokes positive feelings of accomplishment, then more effort and time will be dedicated to the task, a larger number of alternatives will be generated and examined, and a non-routine approach will be used to generate these ideas (Amabile 1990). Furthermore, since creative ideas usually deviate from the status quo, the decision-maker has to be motivated to defy the crowd, i.e. the decision-maker has to be willing to take risk when presenting his or her ideas (Amabile 1983). Hence, we assume that:

H4d: The decision-maker's motivation to solve challenging problems will have a positive effect on the creativity of the solution.

3.3.2 Solution Usability

From the creativity literature (e.g., Amabile 1983; Boden 1994) we know that in creative acts originality and usefulness are intertwined. As mentioned earlier, here we assume that creativity antecedes usability. Thus:

H5a: The creativity of the solution will have a positive effect on the usability of the solution.

Case-based reasoning systems contain a large repository of easily accessible, existing domain knowledge from which relevant elements for solving the problem at hand can be used. Irrespective of the decision-maker's ability to recognize the exact analogy between the new and the retrieved cases, he or she may transfer relevant knowledge from the base to the target solution. For instance, searching the knowledge base of the CBR-system for past SP-cases that had the objective to increase brand awareness with a relatively small budget could result in the retrieval of cases that all used a contest or competition as promotion technique. As a result, the decision-maker will be inclined to use a contest to promote his/ her sales, since this technique has been successfully applied to past, similar problem situations.

Moreover, the knowledge that is transferred from the base to the target solution is derived from validated cases, i.e. one knows whether the outcome was a success or a failure. So, one can capitalize on previous knowledge. We assume that the more the decision-maker capitalizes on knowledge from previous cases, the higher the impact will be that he or she attributes to the use of the CBR-system for developing the solution. In this case the CBR-system is used as an efficient provider of usable solutions, and not so much for creative purposes. Hence, we expect that perceived impact of the CBR-system on the solution will be positively related to its usability. Thus, we posit that:

H5b: The perceived impact of the CBR-system on the final solution will have a positive effect on the usability of the solution.

To come up with a usable and feasible solution, the decision-maker has to be able to judge the value or potential in each idea and synthesize the most promising ideas into an implementable solution (Sternberg et al. 1997). For this, the decision-maker has to posses the ability to think convergently, i.e. translate ideas into concrete solutions. As Sternberg (1999) argues, for solving problems successfully, one needs three types of intellectual abilities: 1) creative abilities to come up with new ideas (including divergent thinking) 2) analytical abilities to evaluate if it is a good idea (including convergent thinking) and 3) practical abilities to sell the idea (including the ability to apply, use, implement and put into practice) (see also Sternberg and Lubart 1992, Sternberg et al. 1997). These abilities are relatively independent, i.e. "one can be adept in any one of these abilities without being adept in any of the others" (Sternberg et al. 1997).

If a decision task requires creativity, then it is better to postpone the analytical (and practical) ability until one has practiced his or her creative ability in generating multiple options to evaluate (Sternberg et al. 1997). However, once the decision-maker has generated many promising ideas (in conjunction with the CBR-system or not), he or she needs the ability to converge these ideas into a usable solution. Thus:

H5c: A convergent thinking style of the decision-maker will have a positive effect on the usability of the solution.

In addition, in the same way as for the creative component of solution quality, we hypothesize that:

H5d: The decision-maker's motivation to solve challenging problems will have a positive effect on the usability of the solution.

4 METHODOLOGY

4.1 The CBR-System

We used existing CBR-software to build our sales-promotion application. Haque, Belecheanu, Barson and Pawar (2001) have compared the performance of four commercially available CBR-shells on the following criteria: ability to represent cases, reasoning dimension and speed, customization, database support, platform use and price. The CBR-shell we used, viz. CBR-Works4 Professional develop by Tec:Inno GmbH, was positively evaluated on all dimensions.

Within this CBR-shell, we developed a knowledge-base structure that was flexible enough (i.e., modular and multi-layered), though explicit and complete enough on important issues (Buchanan 2001) in the sales promotion domain. The domain model, which basically includes variables related to the problem situation (i.e., the market situation, campaign objectives and constraints), the solution (i.e. the campaign design and its execution) and the outcomes), was subsequently used to collate the sales-promotion cases against (see for an example Table 1). All the variables can serve as input for a new case and, subsequently, start the CBR-cycle (see Figure 1). The knowledge base of our CBR-system contained 50 cases, which comprised prize-winning SP-campaigns in the Netherlands from 1981 up to the first half of 1993 (Meetlatcomité Nederland 1994).

Insert Table 1 about here

4.2 The Decision Task

The sales-promotion problem given to the respondents was identical to an actual contest that had been organized and executed by a leading Dutch/ British fast moving consumer good (FMCG) company in 2000. The company announced a SP-design contest on the internet to which (student) teams could subscribe. To subscribe, teams had to send in a design for an original, attention-grabbing SP-campaign for the introduction of four new flavors of a ready-made food product on the Dutch market. For each flavor the best proposal was to be executed. The marketing managers of the FMCG-company determined the overall winner based on an assessment of the effectiveness of each campaign, i.e. the amount of "rumor" that was created around each flavor. Based on that criterion, the team of the flavor "Ketjap" eventually won the contest. We formulated our problem statement similar to the one used by the FMCG-company for the "Ketjap" flavor. In abbreviated form, the assignment was as follows:

> A leading Dutch/ British producer of fast moving consumer goods wants to introduce four new flavors of "Noodles" on the Dutch market. *Your task is to design a Sales Promotion campaign for the "Ketjap" flavor*. The objective of the sales promotion campaign is to generate as much awareness among Dutch consumers (especially adolescents and young adults) as possible. In addition, the campaign has to convey the desired image of the brand and flavor. The desired image of the Noodles brand is: "ready-made food that is very well edible". The Indonesian "Ketjap" (i.e., soy sauce) flavor is honest and exotic. People that have a liking for "Ketjap" are mysterious types, which should be expressed in an exotic and exciting campaign.

Additional information was given about the budget (only 9000 Euro), the availability of 4,000 free "Noodles" sample packages, the execution period (August/ September) and the running time of the campaign (between one day and one month). These constraints were the same as for the original contest of the FMCG-company.

4.3 Respondents and Data Collection

The method of data collection is depicted in Table 2. An international class of 35 third-year students, who were enrolled in a course on "Marketing Strategies and Marketing Intelligence in the Era of Information Technology", participated in the experiment. In total, sixteen teams of two persons and one of three persons were asked to write a proposal for a sales promotion campaign. All teams had the CBR-system at their disposal. However, the teams decided themselves upon the number of minutes/ hours that they used the CBR-system.

Insert Table 2 about here

Together with handing in a two-page SP-campaign proposal, the teams had to answer the following questions: 1) how long they used the CBR-system (in minutes), and 2) how much impact the use of the CBR-system had on their solution (in percentages). After the experiment, additional data from the respondents was gathered regarding their thinking styles, problem-solving motivation, attitude towards MSS usage, and the perceived usefulness of the CBR-system. Finally, the SP-campaign proposals were evaluated on their creativity by two SP-experts from renowned SP-agencies, and evaluated on their usability by the manager of the FMCG-company who had been in charge of the actual contest. The proposals were graded and constituted a part of the students' final grade for the course.

4.4 Measures

4.4.1 Decision-maker Characteristics

Thinking Styles and Motivation. We used 8 items from Hellriegel and Slocum (1992)'s "Personal Barriers to Creative Thought and Innovative Action" checklist[7] to measure the following decision-maker's characteristics:

- Divergent Thinking Style (DTS)

[7] Massetti (1996) also used items from this checklist to "provide a general determination of each subject's ability to perform creatively" for her study into the value of creativity support system for idea generation.

- Convergent Thinking Style (CTS)
- Motivation to Solve Challenging Problems (MSCP)

Insert Table 3 about here

An alpha factor analysis (Kaiser and Caffrey 1965) with oblique rotation (Promax) on these 8 items yielded three factors, which we labeled "divergent thinking style" (3 items), "motivation to solve challenging problems" (3 items) [8], and "convergent thinking style" (2 items) respectively and together explain 70.3% of total variance (see Table 3). In alpha factoring, one assumes that the items being factored represent a sample. This method maximizes the reliability (Cronbach's alpha) of the factors, and is specifically designed to be used in scale construction and testing. An oblique rotation procedure was employed to allow for correlated factors.

From the structure matrix (see Table 3) - in which the coefficients are the correlation of each item with each factor - we can read that all items have their highest loading on the expected factor, although the divergent thinking style item "I seek many ideas because I enjoy having alternative possibilities" showed a substantial positive loading (>0.50) on the "convergent thinking style" factor as well. The factor correlation matrix (see Table 3) shows that divergent thinking style and convergent thinking style are moderately correlated (r=0.43), but distinct constructs. This value has face validity considering the empirical evidence regarding the

[8] The items loading on this factor are comparable to those of Susan Harter (1981)'s "preference for challenge" scale. The preference for solving hard, complex problems connotes an intrinsic motivation and the willingness to take risk to solve such problems (Harter 1981). In our motivational construct, we combine two key factors that play an important role with respect to the outcome of the problem-solving process: 1) the decision-maker's intrinsic motivation to perform the task being studied (see, for example, Amabile 1983; Sternberg and Lubart 1992) and, for creative acts in particular, 2) the willingness to take risk (see, for example, Hogarth 1980; Amabile 1983; Sternberg and Lubart 1992; Andrews and Smith 1996).

relationship between creativity – typically measured by divergent thinking ability tests – and intelligence – typically measured by convergent thinking ability tests (IQ-tests). Creativity and intelligence are found to be more highly correlated in the lower and midrange levels of intelligence, but above a certain threshold level (IQ=120) the correlation is rather low (see Amabile 1983; Runco 1990; Eysenck 1994). Given our student sample, the moderate correlation between divergent thinking and convergent thinking is reasonable in that perspective. Regarding the internal consistency of the scales, we find reliable (α=0.80) to moderately reliable (α=0.56) scales (see Table 3). We used the averaged items scores on each scale in the subsequent analyses[9].

Perceived Usefulness. We adapted six items from a validated scale developed by Davis (1989) for measuring the "perceived usefulness of information technology applications"[10] to measure the perceived usefulness of the CBR-system (PUC). We performed a factor analysis (PCA) on the six items to check for unidimensionality (see Table 4). This resulted in one factor that we labeled "perceived usefulness of the CBR-system", which explained 84.2% of total variance (see Table 4). All items loaded substantially (>0.50) on this factor. A reliability check on these six items revealed a highly reliable scale (α=0.96) (see Table 4). In the subsequent analyses, we therefore use the average item score on this construct.

Insert Table 4 about here

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[9] The checklist is originally designed to detect personal barriers to creativity. The items are therefore phrased in the direction of the absence of barriers with answer categories ranging from 1 (completely agree) to 6 (completely disagree). Hence, high scores denote a barrier. Likewise, by reversing the scales (i.e., 1 = completely disagree and 6 = completely agree), low scores signify barriers to creativity and high scores denote facilitators. We used the latter interpretation of this measurement scale.

[10] Comparable items were also used and validated by Van Bruggen (1993) for measuring the "perceived usefulness of Marketing Management Support Systems".

4.4.2 CBR-system Usage

CBR-system Usage Time. Usage time is measured by the number of minutes that the decision-maker uses the CBR-system in the process of finding a solution (self-reported). The average CBR-usage time was 106 minutes (std. dev. = 38 min.).

Perceived Impact of Using the CBR-system. Perceived impact is measured by the percentage of the final solution that the decision-maker attributes to the impact of CBR-system usage (self-reported). The average perceived impact of the CBR-system on the final solution was 50% (std. dev. = 28%).

4.4.3 Solution Quality

Solution Creativity. To measure the creativity of the solution, we followed the consensual agreement technique (Amabile 1983). The rationale for this technique is that "a product or response is creative to the extent that appropriate observers independently agree that it is creative. Appropriate observers are those familiar with the domain in which the product was created or the response articulated" (Amabile 1983). We asked two sales-promotion experts to judge the SP-campaign proposals - independently, and using their own expert criteria - on two items: *novelty* and *creativity*[11]*.* Both judges have gained many years of experience in the sales-promotion business, for a large part as managing/ creative director, and were unaware of the hypotheses underlying this study.

In total we thus have 34 (17 proposals x 2 judges) creativity and novelty ratings. The highly significant correlation between the novelty and creativity items (r=0.84) and their reliability (α=.91), allows us to aggregate both items and calculate an average "*solution creativity*" score.

Solution Usability. To assess the (practical) usability of the SP-campaign proposals, we asked the executive marketing manager of the FMCG-company to rate the proposals on three items:

[11] All solution quality items are measured on a seven-points Likert-scale

usefulness, *feasibility*, *association with the Uno Noodles brand and “Ketjap” flavor*. We aggregated the ratings on usefulness, feasibility and association (α = .89) to calculate an average score on “*solution usability*”. Note that, since we used only one judge, in total we have 17 observations for solution usability.

5 RESULTS AND CONCLUSIONS

5.1 CBR-system Usage

First of all, does CBR-system usage help to improve the quality of the solution? To be able to answer this question, we let the marketing manager of the FMCG-company also judge the overall quality of our students teams' SP-campaign proposals in comparison with the winning "Ketjap" campaign from the original contest. There were 50 entrants for the "Ketjap" flavor. Assuming that our student teams and the entrants to the original SP-campaign design contest of the FMCG-company come from approximately the same population and that the only difference between the two samples is the use of the CBR-system[12], we thus can compare the results for CBR-system usage versus non-usage.

Eventually, 5 out of the 17 student team proposals were judged to be of better quality than the original, prize-winning "Ketjap" campaign. Furthermore, three proposals were of comparable quality. The probability that 5 or more SP-campaign proposals from a sample of 17 proposals are of better quality than the best campaign from a sample of 50 proposals for the "Ketjap" flavor from the same population is negligible[13]. This result provides evidence that CBR-system usage does improve the quality of the solution (H1).

Next, we turn to the conditions under which CBR-system usage is most effective. We conducted a number of multiple regression analyses in which we used one-sided t-tests to test our directed

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[12] Sales promotion practitioners were excluded from participation in the original contest. Moreover, the prize-winning "Ketjap" team consisted of undergraduate university students like we used in our study. To our best knowledge, neither the winning team nor the about 50 other entrants for the "Ketjap" flavor had a support system at their disposal.

[13] In general, the probability that exactly k campaigns out of n campaigns of one sample are of better quality than the best campaign out of m campaigns of a second sample: $\underline{k}$ ~ Binomial (n, π)

$$P(\underline{k} = k) = \binom{n}{k} . \pi^{k} . (1 - \pi)^{n-k} ,$$

Under the null-hypotheses of equality between the samples the probability (π) is 0.02 (i.e., 1 out of 50 campaigns). Thus, for k = 5, n = 17, and π = 0.02 → P($k \geq 5$) = 1 - P($k < 5$) = 1 - 0.9999839 = 0.00001061, with E(*number of times that a solution developed by using the CBR-system is better*) = 0.02*17 = 0.34

hypotheses. Note that in the regression analyses, we included the highest team score on the individually measured decision-maker characteristics, since we worked with teams instead of individuals. Overall, we find that using the highest scores per team produces the best results, as opposed to using average team scores. This is consistent with a study of Malter and Dickson (2001), who found that the (learning) ability of the best member of management teams was closely related to team performance. The results of the regression analyses are discussed next.

Insert Table 5a and Table 5b about here

The results of the regression analyses for CBR-system usage are depicted in Table 5a and 5b, for usage time (R^2_{adj}=0.36) and perceived impact (R^2_{adj}=0.64), respectively. As expected, a convergent thinking style (H2b) exerts a negative and significant influence on CBR-system usage time (b=-0.43; p<0.05), whereas the perceived usefulness of the system (H2c) has a positive, significant impact on CBR-system usage time (b=0.39; p<0.05). We do not find a positive influence (see H2a) of a divergent thinking style on CBR-system usage time (b=-0.16; n.s.).

So, it appears that decision-makers with a high convergent thinking style use the CBR-system for a shorter period of time than decision-makers with a low convergent thinking style. This could either mean that highly convergent thinkers do not like to use the CBR-system in the first place, since it does not match with their preferred thinking style, or that they simply take the *first* appropriate solution provided by the CBR-system as their ballpark solution and modify it until it fits the problem at hand. The latter explanation is, however, less likely since the convergent thinking style and the perceived usefulness of the CBR-system tend to be negatively rather than positively correlated (r=-0.26; p=0.322), which is in agreement with the first explanation.

With respect to the perceived impact of the CBR-system (see Table 5b), we can conclude – in line with hypotheses 3a and 3b - that CBR-system usage time (b=0.38) and the perceived usefulness of the CBR-system (b=0.58) both have a significant, positive effect on the decision-maker's perceived impact of the CBR-system on the final solution. In fact, perceived usefulness has an influence on the perceived impact of the system over, and above, its influence on perceived impact through CBR-system usage time.

The prominence of perceived usefulness as a determinant of support system usage is consistent with the findings of previous research (e.g., Robey 1979; Davis 1989; Davis et al. 1989; Venkatesh and Davis 2000). We add to this finding that the (convergent) thinking style of the decision-maker exerts a strong (negative) influence on system usage time, and thereby indirectly also on the perceived impact of the system on the solution. Apparently, if the system does not match with the decision-maker's thinking style, he or she will not be inclined to use the system.

5.2 Solution Quality

5.2.1 Solution Creativity

First of all, note that we have the creativity ratings of two sales promotion experts. Hence, we follow Dahl and Moreau (2002) and use a judge dummy in the subsequent regression analysis. In this way, we gain degrees of freedom (n=34) compared to using an average judge score, and thus have a higher probability of detecting statistically significant effects. Technically speaking, we allow for heterogeneity in the intercept. That is, we account for possible differences in the judgment *levels* of the SP-experts. We do not find significant differences between the judges with respect to the relative ratings of the teams' proposals[14], therefore we assume homogeneity in the *slopes* for the explanatory variables.

In addition, because we include an interaction term in the regression analysis for solution creativity, we mean-centered all independent variables, following Irwin and McClelland (2001). Mean-centering the variables helps to avoid inflated estimates of standard errors (and thus difficulties with detecting statistically significant effects) due to multicollinearity problems that are introduced by including an interaction term (Cronbach, 1987). Moreover, mean-centering facilitates the interpretation of the coefficients for the separate components of the interaction term[15].

Insert Table 6a about here

The results of the moderated regression analysis are depicted in Table 6a. Since we mean-centered the variables, the beta-coefficients have to be interpreted as their "simple" effect on the dependent variable, at the average value of the other variables[16]. The simple effect for CBR-system usage time is significantly negative (b=-0.31). This means that, at the average divergent

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[14] The solution creativity ratings show considerable inter-judge reliability (α = 0.71), which is also indicated by the significant p-value for Kendall's coefficient of concordance (W) (0.81; p = 0.057). Kendall's W is a non-metric, rank order statistic for inter-judge reliability.

[15] In a moderated regression analysis, the coefficients for the components of the interaction term represent their "simple" effects, i.e., the simple relationship between the dependent variable and independent variable at a particular level of the other independent variable(s) (Irwin and McClelland 2001). Because the value zero is outside the range for the variables included in the interaction term (viz., divergent thinking style and CBR-system usage time), the coefficients and its tests have little or no meaning. Mean-centering the variables (i.e., rescaling the mean to zero) facilitates the interpretation of the simple effects, they then represent the effect of the independent variable at the average value of the other independent variable(s) (see Aiken & West, 1991; Irwin and McClelland 2001). Mean-centering changes the correlations between either component of the interaction term and the interaction term itself (e.g., X and XZ), reducing multicollinearity problems, and between the dependent variable and the interaction term (e.g., Y and XZ) (see Irwin an McClelland 2001).

thinking level (DTS=0), an increase in CBR-system usage time has a negative impact on the creativity of the solution. Thus, an above average usage time of the CBR-system does not guarantee that the creativity of the solution improves. It could be that high usage times simply reflect an inability of the decision-maker to properly use the CBR-system, although we do not have reasons to expect this since the system is very user-friendly and the students did not report any problems with using it. More likely, however, is that the effect of high CBR-system usage times is different for different types of decision-makers. The latter explanation is supported by the positive and significant interaction effect of a divergent thinking style and CBR-system usage time (b=0.32), as hypothesized (H4b). Thus, only for more than average divergent thinkers prolonged CBR-system usage leads to more creative solutions. We could not confirm a positive simple effect for CBR-system usage (H4a) and for divergent thinking (H4c).

Finally, the sign of the coefficient for the motivation of the decision-maker to solve challenging problems is positive (b=0.17; n.s.), as expected (see H4d). Although the creativity literature (e.g., Amabile 1983) stresses the importance of motivation, in this study we do not find a significant relationship with the creativity of the outcome. A reason for this could be that, by grading the student's proposals, we also extrinsically motivated them, which is often argued to have a negative effect on creativity (see Amabile 1998).

To recap, the results suggests that a reinforcement strategy, i.e. supporting creative, divergent thinkers with idea generating software, produces the best outcomes. That is, CBR-system usage seems to particularly enhance the innate fluency (i.e., the ability to generate many ideas) of highly divergent thinkers.

5.2.2 Solution Usability

The regression coefficients for perceived impact of using the CBR-system (b=0.13) and convergent thinking style (b=0.03) turn out to be non-significant, though positive as hypothesized (H5b and H5c, respectively) (see Table 6b; R^2_{adj}= 0.41). Interestingly, the perceived impact of the CBR-system on the solution does not have a significant relationship with the usability of the solution. Thus, although the student teams might attribute a large part of their final solution to the impact of the CBR-system, this does not seem to add much to the usability of their solution (as judged by the executive manager).

Insert Table 6b about here

The usability of the solution very much depends on the creativity of the solution (b=0.60). This close link between creativity and usability (H5a) is in line with the findings reported in the creativity literature (see Amabile 1983; Sternberg and Lubart 1992). Furthermore, it is important that the decision-maker is motivated enough to solve the challenging problem (b=0.40; H5d). These findings apply to our student setting. Sales promotion practitioners are more likely to be intrinsically motivated to perform their job, so for them this variable might play a less important role. Hence, other variables like, for example, their level of expertise might become more important.

6 DISCUSSION

6.1 Major Findings

We summarize our findings in Table 7. First of all, we find convincing evidence for our hypothesis that using the CBR-system does help to find better solution. The first conclusion is that by using the CBR-system the quality of the solution is improved compared to not using the system. Furthermore, in line with previous research (see Venkatesh and Davis 2000), we see that perceived usefulness is an important driver of CBR-system usage, both of usage time and the perceived impact of the system on the solution (over and above the influence of usage time). Hence, improving the perceived usefulness of the system, e.g. by training or education, could help to improve CBR-system usage.

Insert Table 7 about here

To this finding, we add that the match between the thinking style of the decision-maker and the system also seems to be important. In this study, a convergent thinking style has a strong negative impact on CBR-system usage time (see Table 7), probably because their thinking style does not match with the CBR-system (which better suits a divergent thinking style by its ability to stimulate idea generation). As a result of the mismatch between the system and the decision-maker's preferred thinking style, compensated decision-makers could have difficulties in interpreting and, subsequently, applying the system's output (O'Keefe 1989). Another possible reason could be that convergent thinkers simply take the first solution provided by the system and modify it until it fits all constraints of the current problem, although we did not find evidence for this.

On the other hand, the hypothesized positive effect of the match between the system and a divergent thinking style could not be confirmed (see Table 7). The positive effect of a match with their thinking style might be offset by a reluctance of highly divergent, creative minds to allow *a system* to interfere in their creative process in the first place. Such people could (and did[16]) argue that using the CBR-system constrains their creativity by fixing their attention to the solution pathways given in the examples provided by the system (so-called “form fixation” or “unconscious plagiarism”, see Dahl and Moreau 2002). So, they might decide to rely on their own creative thoughts instead of using the CBR-system.

Prolonged CBR-system usage time has a positive impact on the creativity of the solution for above average divergent thinkers. That is, highly divergent (creative) thinkers who use the CBR-system longer produce more creative SP-campaign proposals. In turn, at least in our “Uno Noodles” case, solution creativity positively influences the usability of the solution. We could not confirm a direct positive influence of CBR-system usage time and the perceived impact of the CBR-system on solution creativity and usability, respectively. In sum, regarding the conditions under which CBR-system usage is most effective, a reinforcement strategy seems to work out best, i.e. providing divergent (creative) thinkers with an idea-generating tool. Based on our findings, we conclude that the CBR-system can be an effective tool for supporting the weakly-structured, high-level sales promotion decisions as described in the introduction.

6.2 Limitations and Further Research

We find that for decision-makers who think highly divergent the creativity and, consequently, the usability of their solution improve as they use the CBR-system for a longer period of time. To gain deeper insight in the conditions under which CBR-system usage is most effective, additional studies are planned. We would also like to the explore other factors that may drive our results,

[16] A number of respondents mentioned this explicitly in their SP-campaign proposal, though they were not aware of the purpose of this study.

such as the influence of 1) the size of the knowledge-base (i.e., the number of cases contained in the system), 2) expert versus novice decision-making (see, for example, Mackay and Elam 1992), and 3) the scope of the knowledge-base (i.e., the use of intra-domain versus inter-domain cases; see, for example, Dahl and Moreau 2002).

The effectiveness of the CBR-system is likely to be dependent on the size of its knowledge base. It would be logical to expect that the larger the number of cases stored in the knowledge-base, the larger the probability that the system comes up with a matching solution and, eventually, the better the quality of the solution will be. Thus, the more cases the better.

Next, knowledge-driven Management Support Systems, like CBR-systems, can compensate for the lack of domain knowledge and remove cognitive biases on the part of the decision-maker. This would imply that expert decision-makers, who presumably posses a large body of domain knowledge (i.e., they are knowledgeable of many previous cases within their domain), will benefit less from an MSS since the knowledge it provides will not add much to the knowledge they already possess. Nevertheless, the system could still be helpful to overcome cognitive biases, like selective perception or selective memory, and thus enhance expert decision-making by serving as an artificial memory and facilitate the retrieval of previous, analog cases.

Besides fluency, other aspects of divergent thinking are flexibility and originality (Guilford 1967). Flexibility is defined as the number of different categories to which the responses belong, whereas originality refers to the unusualness (i.e., statistical rarity) of the responses (Sternberg and Lubart 1992). The extent to which the CBR-system can enhance the decision-maker's flexibility and originality will probably depend very much on the nature of the cases provided by the system, viz. intra-domain or inter-domain. For instance, Bonnardel (2000) found that providing decision-makers with inter-domain analogies enhances creativity more than when using intra-domain analogies. Dahl and Moreau (2002) found no effect of priming *intra*-domain analogies on the creativity of the outcome at all. Hence, they speculated that using far (i.e., inter-domain) analogies would probably stimulate creativity more than using near (i.e. intra-domain) analogies. In the present study, we were not able to draw any conclusions regarding this issue, since we did not have systematic information about the specific cases that the student teams have used.

Finally, the effectiveness of the CBR-system may also depend on the combination of the decision-maker's level of expertise and the type of cases he or she uses. To put it differently, experts may benefit more from a case-based reasoning system as an idea-generation tool than as a knowledge transfer tool (i.e., artificial memory), while for novice decision-makers this may be the other way round. Therefore, the optimal size and scope of the knowledge base of the CBR-system could be dependent on the type of user.

A methodological issue concerns the use of a between-subject versus a within-subject study. In line with previous studies on creativity and decision support systems (e.g., Elam and Mead 1990; Massetti 1996; Marakas and Elam 1997), we performed a between-subject analysis. However, by conducting a within-subject study (see, for example, MacCrimmon and Wagner 1994) one could control for individual differences, such as the possession of prior marketing knowledge, motivation, and the cognitive style of the decision-maker. For instance, in this study we used marketing students who presumably possess more knowledge of marketing and sales promotions than the average entrant to the original contest organized by the FMCG-company. Assigning the same respondent first to a "non-usage" condition and then to a "usage" condition (and vice versa) and comparing the results between both conditions, would effectively rule out the explanation that the results are due to individual differences rather than CBR-system usage. However, a within-subject design introduces other problems, such as learning effects.

Finally, our sample size is rather small, but comparable to other studies conducted in this field (e.g., Elam and Mead 1990; Connolly, Jessup, and Valacich 1990) Nevertheless, we did succeed in finding some intriguing, significant effects. However, to gain statistical power, we need to enlarge the sample size in future studies.

6.3 Managerial Implications

We have evidence that using a CBR-system can improve the creativity and the usability of solutions in a weakly-structured, high-level problem domain, viz. the design of sales promotion campaigns. It would be wise for companies and sales promotion agencies to start building a knowledge base by capturing, organizing and storing sales promotion cases in a CBR-system, and subsequently putting them into action for decision-making. This is not yet common practice, at least not for Dutch sales promotion agencies and companies.

Moreover, it appears that CBR-system usage is most beneficial for decision-maker's who think highly divergent. The people who design sales promotion campaigns are usually so-called "creatives" and are hired because of their creative, divergent thinking skills. So, providing them with the CBR-system could significantly enhance the creativity of their output, and consequently improve their company's performance. However, as our results suggest, they could be reluctant the use a *system* in their creative process. Since actual CBR-system usage is closely related to its perceived usefulness, top management support (e.g., by providing training and education) could probably help to overcome the decision-maker's reluctance to use the CBR-system.

By capturing and storing all relevant marketing knowledge that is present in- or outside the company in a knowledge repository, the firm's knowledge is made more independent of persons or existing knowledge networks (e.g., communities of practice). Systematically storing sales promotion cases (including problem situation, solution and outcomes) and putting them into action for decision-making is not (yet) common practice, neither for the companies that engage in SP-campaigns nor for the agencies that design them. This relates to the topic of knowledge management, which is nowadays considered to be of utmost importance for companies to gain and sustain a competitive advantage (see, for a review, Alavi and Leidner 2001).

Making existing knowledge independent of persons or networks, knowledge management has some additional practical advantages, such as securing the knowledge for the company, facilitating the training of novices, less danger of “reinventing-the-wheel”, detecting knowledge gaps more easily, and saving time when searching for knowledge within the company (Ülpenich, 1999).

The emergence of knowledge-driven AI-techniques like CBR, in our opinion, greatly enlarges the possibilities for supporting managerial decision-making and knowledge production. Whereas traditional techniques rely heavily on the availability of data (e.g., information systems), deep knowledge (e.g., expert systems), and the structuredness of the problem (e.g. econometric/ analytical models), knowledge-driven techniques are able to put also soft, qualitative knowledge such as judgments, hunches and intuition (resulting from past problem-solving experiences), into action (see Fowler 2000). As Fowler (2000) states: “the combination of formal, explicit knowledge in the machine, and the non-formal, tacit knowledge of the user, can result in problem-solving capabilities which *surpass* either one of these components acting alone”.

Ideally, in the near future management support systems should be flexible, multipurpose systems consisting of a quantitative, data-driven, rule-based component as well as a qualitative, knowledge-driven, case-based component (so-called case-based reasoning *integrations,* see Marling et al. 2002). In this way, the system can accommodate to all kinds of decision-makers and problem situations, and both reinforce the strengths of the manager as well as to compensate for weaknesses.

REFERENCES

Aamodt, A., and Plaza, E. “Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches,” *AI Communications* (7:1), 1994, pp. 39-59.

Aiken, L.S., and West, S.G. *Multiple Regression: Testing and Interpreting Interactions*. Sage Publications, Newbury Park, CA, 1991.

Alavi, M., and Leidner, D.E. “Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues,” *MIS Quarterly* (25:1), March 2001, pp. 107-137.

Althoff, K.-D., Auriol, E., Barletta, R., and Manago, M. *A Review of Industrial Case-Based Reasoning Tools*. Oxford, UK, 1995.

Amabile, T.M. *The Social Psychology of Creativity*. Springer-Verlag, New York, 1983.

Amabile, T.M. “Within You, Without You: The Social Psychology of Creativity, and Beyond,” in *Theories of Creativity*. M.A. Runco and R.S. Albert (eds.), Newbury Park, CA, Sage Publications, 1990, pp. 61-91.

Amabile, T.M. “How to kill Creativity,” *Harvard Business Review* (76:5), 1998, pp. 77-87.

Andrews, J., and Smith, D.C. “In Search of the Marketing Imagination: Factors affecting the Creativity of Marketing Programs for Mature Products.” *Journal of Marketing Research* (33:2), May 1996, pp. 174-187.

Baer, J. *Creativity and Divergent Thinking Task-Specific Approach,* Lawrence Erlbaum, Hillsdale NY, 1993.

Basadur, M., Ellspermann, S.J., and Evans, G.W. “A New Methodology for Formulating ill-structured Problems,” *OMEGA* (22:6), June 1994, pp. 627-645.

Benbasat, I., and Dexter, A.S. “Individual Differences in the Use of Decision Support Aids,” *Journal of Accounting Research* (20:1), Spring 1982, pp. 1-11.

Benbasat, I., and Dexter, A.S. “An Experimental Evaluation of Graphical and Color Enhanced Information Presentation,” *Management Science* (31:11), November 1985: 1348-1364.

Benbasat, I., and Nault, B. “An Evaluation of Empirical Research in Managerial Support Systems,” *Decision Support Systems* (6:3), 1990, pp. 203-226.

Blattberg, R.C., and Hoch, S.J. “Database models and managerial intuition: 50% model and 50% manager,” *Management Science* (36:8), August 1990, pp. 887-899.

Boden, M.A. *The Creative Mind: Myths and Mechanisms*, Weidenfeld and Nicolson, London, 1991.

Boden, M.A. “What is creativity?” in *Dimensions of Creativity,* M.A. Boden (ed.), The MIT Press, Cambridge, 1994, pp.75-117.

Bonnardel, N. "Towards Understanding and Supporting Creativity in Design: Analogies in a Constrained Cognitive Environment," *Knowledge-Based Systems* (13:7-8), December 2000, pp. 505-513.

Buchanan, B.G. "Creativity at the Metalevel: AAAI-2000 Presidential Address," *AI Magazine* (22:3), Fall 2001, pp. 13-28.

Chakravarti, D., Mitchell, A., and Staelin, R. "Judgment Based Marketing Decision Models: An Experimental Investigation of the Decision Calculus Approach," *Management Science* (25:3), March 1979, pp. 251-263.

Cohen, H. "Colouring Without Seeing: A Problem in Machine Creativity," *AISB Quarterly* (Issue 102), Summer-Autumn 1999, pp. 26-35.

Connolly, T., Jessup, L.M., and Valacich, J.S. "Effects of Anonymity and Evaluative Tone on Idea Generation in Computer Mediated Groups," *Management Science* (36:6), June 1990, pp. 689-703.

Cronbach, L. J. "Statistical Tests for Moderator Variables: Flaws in Analysis Recently Proposed," *Psychological Bulletin* (102:3), 1987, pp. 414-417.

Dahl, D.W., and Moreau, P. "The Influence and Value of Analogical Thinking during New Product Ideation," *Journal of Marketing Research* (39:2), February 2002, pp. 47-60.

Davis, F.D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:3), September 1989, pp. 319-340.

Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. "User Acceptance of Computer Technology: A comparison of two theoretical models," *Management Science* (35:8), August 1989, pp. 982-1003.

De Waele, M. "Managerial Style and the Design of Decision Aids," *OMEGA* (6:1), February 1978, pp. 5-13.

Elam, J.J., and Mead, M. "Can Software influence Creativity?" *Information Systems Research* (1:1), March 1990, pp. 1-22.

EFSP Awards. *Presentation of the European Federation of Sales Promotion (EFSP) Best of Europe Sales Promotion Awards*, Maastricht, The Netherlands, on CD-ROM, 2001.

Eysenck, H. J. "The Measurement of Creativity," In *Dimensions of Creativity*, M.A. Boden (ed.), The MIT Press, Cambridge, 1994, pp. 199-242.

Fowler, A. "The role of AI-based technology in support of the knowledge management value activity cycle," *Journal of Strategic Information Systems* (9:2-3), September 2000, pp. 107-128.

Goodhue, D. L., and Thompson, R.L. "Task-Technology Fit and Individual Performance," *MIS Quarterly* (19:2), June 1995, pp. 213-236.

Gorry, G.A., and Scott Morton, M.S. “A Framework for Management Information Systems.” *Sloan Management Review* (13:1), Fall 1971, pp. 55-70.

Guilford, J.P. *The Nature of Human Intelligence*, McGraw-Hill, New York, 1967.

Guilford, J.P. *Intelligence, Creativity, and their Educational Implications*, Robert R. Knapp, San Diego, CA, 1968.

Haque, B.U., Belecheanu, R.A., Barson, R.J., and Pawar, K.S. “Towards the Application of Case Based Reasoning to Decision Making in Concurrent Product Development (concurrent engineering),” *Knowledge-Based Systems* (13:2-3), April 2000, pp. 101-112.

Harter, S. “A New Self-Reported Scale of Intrinsic versus Extrinsic Orientation in the Classroom: Motivational and Informational Components,” *Developmental Psychology* (17), 1981, pp. 300-312.

Hellriegel, D., and Slocum, J.W. *Management, 6th edition*. Addison-Wesley, Reading, MA, 1992.

Hogarth, R. *Judgment and Choice*, Chichester, England, John Wiley & Sons, 1980.

Huber, G.P. “Cognitive style as a basis for MIS and DSS designs: Much ado about nothing?” *Management Science* (29:5), May 1983, pp. 567-579.

Hunt, R.G., Krzystofiak, F.J., Meindl, J.R., and Yousry, A.M. “Cognitive Style and Decision Making,” *Organizational Behavior and Human Decision Processes* 44:, 1989, pp. 436-453.

Irwin, J. R., and McClelland, G.H. (2001). “Misleading Heuristics and Moderated Multiple Regression Models,” *Journal of Marketing Research* (38:1), February 2001, pp. 100-109.

Kaiser, H. F., and Caffrey, J. “Alpha factor analysis,” *Psychometrika* (30), 1965, pp. 1-14.

Keen, P.G.W., and Scott-Morton, M.S.C. *Decision Support Systems: an organizational perspective,* Addison-Wesley, Reading, Massachusetts, 1978.

Kletke, M.G., Mackay, J.M., Barr, S.H. and Jones, B. “Creativity in the Organization: The Role of Individual Creative Problem Solving and Computer Support,” *International Journal of Human-Computer Studies* (55:3), March 2001, pp. 217-237.

Koestler, A. (1964). *The Act of Creation*. Macmillan, New York, 1964.

Kolodner, J.L. *Case-Based Reasoning*. Morgan Kaufmann Publishers Inc., San Mateo, CA, 1993.

Leake, D.B., Ed. *Case-Based Reasoning: Experience, Lessons & Future Directions,* AAAI Press/MIT Press, Menlo Park, California,1996.

Leeflang, P.S.H., and Wittink, D.R “Building Models for Marketing Decisions: Past, Present, and Future,” *International Journal of Research in Marketing* (17:2-3), September 2000, pp. 105-126.

Liang, T.-P. “Analogical Reasoning and Case-Based Learning in Model Management Systems,” *Decision Support Systems* (10:2), August 1993, pp. 137-160.

MacCrimmon, K.R., and Wagner, C. “Stimulating Ideas through Creativity Software,” *Management Science* (40:11), November 1994, pp. 1514-1532.

Mackay, J.M., and Elam, J.J. “A Comparative Study of how Experts and Novices use a Decision Aid to Solve Problems in Complex Knowledge Domains,” *Information Systems Research* (3:2), June 1992, pp. 150-172.

Malter, A.J., and Dickson, P.R. “The Effect of Individual Learning on Competitive Decision Making and Firm Performance,” *International Journal of Research in Marketing* (18:1-2), June 2001 pp. 99-117.

Marakas, G.M., and Elam, J.J. (1997). “Creativity Enhancement in Problem-Solving through Software or Process?” *Management Science* (43:8), August 1997, pp. 1136-1146.

Marling, C., Sqalli, M., Rissland, E., Munoz-Avila, H., and Aha, D. “Case-based Reasoning Integrations,” *AI Magazine* (23;1), Spring 2002, pp. 69-86.

Mason, R.O., and Mitroff, I.I. “A Program for Research on Management Information Systems,” *Management Science* (19:5), January 1973, pp. 475-487.

Massetti, B. “An Empirical Examination of the Value of Creativity Support Systems on Idea Generation,” *MIS Quarterly* (20:1), March 1996, pp. 83-97.

Meetlatcomite-Nederland*. Scoren boven op onder de lijn: succesvolle promotion cases*. Breukelen, Van Lindonk Special Projects BV, 1994.

Money, A., Tromp, D., and Wegner, T. “The Quantification of Decision Support Benefits within the Context of Value Analysis,” *MIS Quarterly* (12:2), June 1988, pp. 223-236.

O'Keefe, R.M. “The Implications of Cognitive-style Findings for Operational Research,” *Journal of the Operational Research Society* (40:5), May 1989, pp. 415-422.

O'Keefe, R.M., and Pitt, I.L. “Interaction with a Visual Interactive Simulation, and the Effect of Cognitive Style,” *Technical Report*, Department of Decision Sciences and Engineering Systems, Rensselaer Polytechnic Institute, Troy NY, 1988.

Riesbeck, C.K., and Schank, R.C. *Inside Case-Based Reasoning,* Lawrence Erlbaum, Hillsdale NY, 1989.

Robey, D. “User attitudes and management information system use,” *Academy of Management Journal* (22:3), September 1979, pp. 527-538.

Rossiter, J.R., and Percy, L. *Advertising Communications & Promotion Management*, *2nd Edition*, McGraw-Hill, New York, 1997.

Rossiter, J.R., and Lilien, G. “New “Brainstorming” Principles,” *Australian Journal of Management* (19:1), June 1994, pp. 61-72.

Runco, M. “Implicit Theories and Ideational Creativity,” In *Theories of Creativity,* M.A. Runco and R.S. Albert (eds.)*,* Sage Publications, Newbury Park, CA, 1990, pp. 234-252.

Schank, R. C., and Cleary, C. “Making Machines Creative,” in *The Creative Cognition Approach*, S. Smith, T.B. Ward and F.A. Finke (eds.), The MIT Press, Cambridge, MA, 1995, pp. 229-247.

Sharda, R., Barr, S., and McDonell, J. “Decision Support System Effectiveness: A review and empirical test,” Management Science (34:2), February 1988,pp. 139-159.

Simon, H.A. “The structure of ill structured problems,” *Artificial Intelligence* (4:3-4), December, 1973, pp.181-201.

Sprague, R.H., Jr., and Watson, H.J. *Decision Support for Management,* Englewoods Cliffs, New Jersey, Prentice-Hall, 1996.

Sternberg, R. J. “Successful Intelligence: Finding a balance,” *Trends in Cognitive Sciences* (3:11), November 1999, pp. 436-442.

Sternberg, R.J., and Lubart, T.I. “The Creative Mind,” *Nederlands Tijdschrift voor de Psychologie* (47:6), 1992, pp. 288-300.

Sternberg, R.J., O'Hara, L.A. and Lubart, T.I. “Creativity as Investment,” *California Management Review* (40:1), Fall 1997, pp. 8-21.

Tardif, T.Z., and Sternberg, R.J. “What Do We Know About Creativity?” in *The Nature of Creativity: Contemporary Psychological Perspectives*, R.J. Sternberg (ed.), Cambridge University Press, Cambridge, MA, 1988, pp. 429-440.

Todd, P., and Benbasat, I. “The Use of Information in Decision Making: An Experimental Investigation of the Impact of Computer-Based Decision Aids,” *MIS Quarterly* (16:3), September 1992, pp. 373-393.

Torrance, E.P. *Torrance Tests of Creative Thinking*. Personal Press Inc., Princeton, NJ, 1966.

Ülpenich, S. “Management of Explicit and Implicit Knowledge in Consulting Companies,” in *Bringing Knowledge to Business Processes,* The AAAI Spring Symposium, AAAI Press/ MIT Press, 1999.

Van Bruggen, G.H. *The Effectiveness of Marketing Management Support Systems: an experimental study*. Ph.D. Dissertation, Eburon, Delft, 1993.

Van Bruggen, G.H., Smidts, A., and Wierenga, B. “Improving Decision Making by Means of a Marketing Decision Support System,” *Management Science* (44:5), May 1998, pp. 645-658.

Van Bruggen, G.H., and Wierenga, B. “Matching Management Support Systems and Managerial Problem-solving Modes: The Key to Effective Decision Support,” *European Management Journal* (19:3), June 2001, pp. 228-238.

Venkatesh, V., and Davis, F.D. “A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies,” *Management Science* (46:2), February 2000, pp. 186-204.

Webby, R., and O’Connor, M. “The Effectiveness of Decision Support Systems: the implications of task complexity and DSS sophistication,” *Journal of Information Technology* (9:1), March 1994, pp.19-28.

Wierenga, B., and Van Bruggen, G.H. “The Integration of Marketing Problem Solving Modes and Marketing Management Support Systems,” *Journal of Marketing* (61:3), July 1997, pp. 21-37.

Wierenga, B., and Van Bruggen, G.H. “The Dependent Variable in Research into the Effects of Creativity Support Systems: Quality and Quantity of Ideas,” *MIS Quarterly* (22:1), March 1998, pp. 81-88.

Wierenga, B., and Van Bruggen, G.H. *Marketing Management Support Systems: Principles, Tools and Implementation*, Kluwer Academic Publishers, Boston, 2000.

Wierenga, B., Van Bruggen, G.H., and Staelin, R. “The Success of Marketing Management Support Systems.” *Marketing Science* (18:3), Summer 1999, pp. 196-207.

Wittink, D.R., Addona, M.J., Hawkes, W.J., and Porter, J.C. “SCAN*PRO: The Estimation, Validation, and Use of Promotional Effects Based on Scanner Data,” *Working Paper*, February 1988.

Zhinkhan, G.M., Joachimstaler, E.A., and Kinnear, T.C. “Individual Differences and Marketing Decision Support System Usage and Satisfaction,” *Journal of Marketing Research* (24:2), May 1987, pp. 208-214.

Zmud, R.W. “Individual Differences and MIS Success: A Review of the Empirical Literature.” *Management Science* (25:10), October 1979, pp. 966-979.

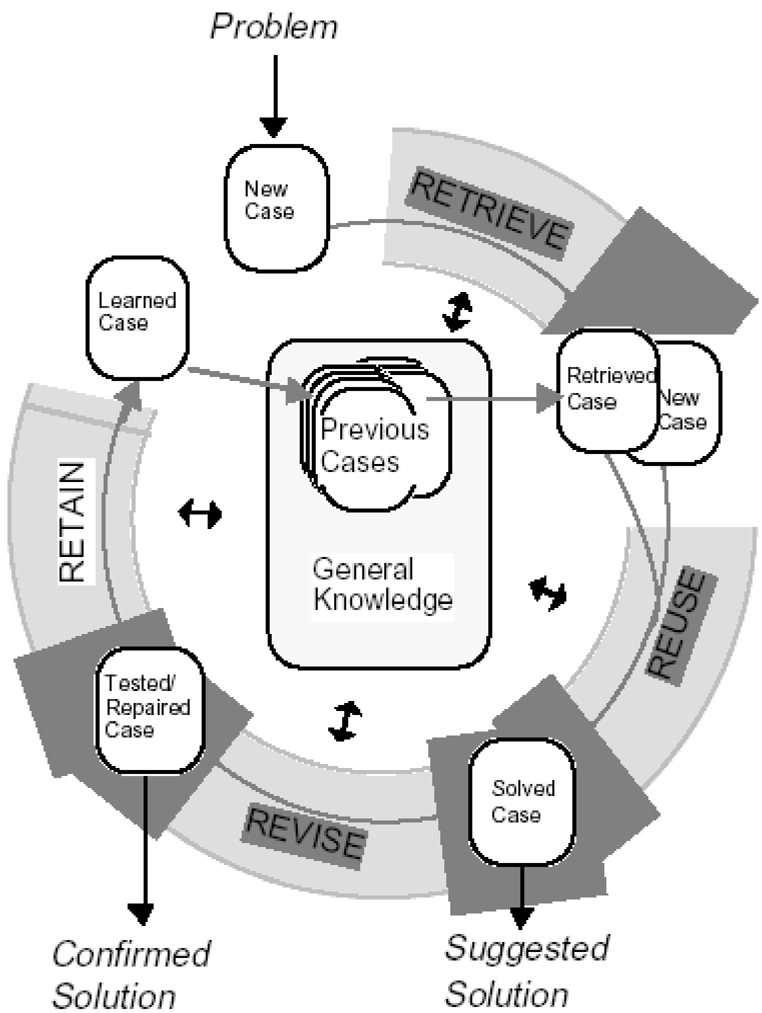

Figure 1 **The CBR cycle (Aamodt and Plaza 1994)**

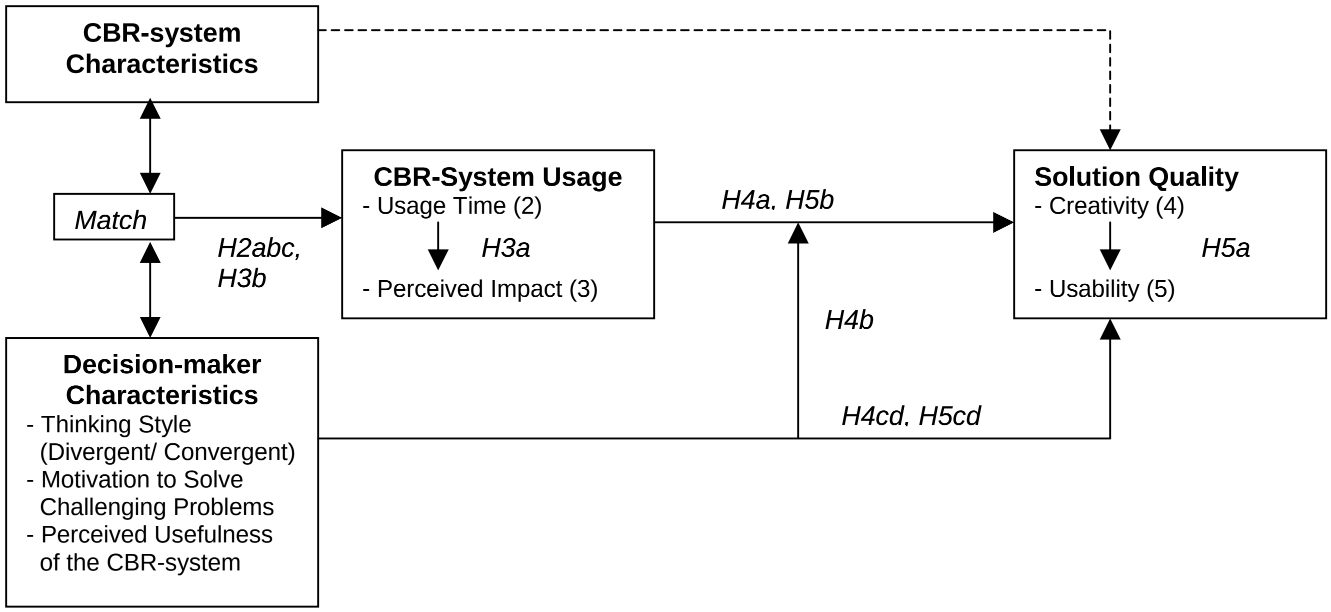

Figure 2 **Framework of how the CBR-system influences the solution of a Sales Promotion Problem**

Table 1 Knowledge Structure in the CBR-system, illustrated by an excerpt of the "Megapool" Case

Basic Structure	***Attributes***	***Value***
1. General Information	001 Campaign Title	"Megapool Cash Refund 2000"
	002 Start Date	'October 17, 1990'
	003 End Date	'November 17, 1990'
	004 Short Case Description	'Megapool - a store chain for household appliances and consumer electronics - amply reached its objectives (to increase sales and awareness) with a simple cash-refund campaign. Basically, Megapool guaranteed a full refund of the purchase price for televisions, washing machines, refrigerators, etc. after 10 years (in 2000). Although customers initially questioned the credibility of this campaign, during the promotion period sales increased with 120% and awareness rose from 35% to 75%. Within a month more than 25,000 customers bought household and electronic appliances with a minimal purchase value of 363 Euro per item. Prior to the main campaign (spring 1990) and in connection with the World Cup Soccer Tournament, Megapool had already offered its customers a 227 Euro refund of the purchase price for televisions and videos on the condition that the Dutch team had to win the World Cup Tournament. In the end, Megapool didn't have to pay this "world-cup" refund.'
	005 Full Case Description	'See casebook: nr. 1'
Problem Situation		
2. Market Situation		
2.1 Product Category Situation	007 Product Category (narrow)	'consumer electronics & household appliances stores'
	008 Category Life Cycle	'maturity'
	009 Price Level	'50 - 999 euro, 1000 - 4999 euro'
	012 Purchase Motivation	'informational'
2.2 Product/ Brand Situation	014 Product/ Brand Name	'Megapool'
	015 Product/ Brand Life Cycle Phase	'growth'
	016 Relative Price	'average'
2.3 Targeted Customers	022 Country/ Region	'the Netherlands'
	023 Age Category	'young adults, adults, middle-aged'
2.4 Competitive Environment	028 Company Name	'Megapool'
	030 Competition Intensity	'high'
3. Campaign Objectives	032 Main Objective(s)	'attract new customers, increase awareness'
4. Constraints	035 Campaign Duration	'short-term (several days/ weeks)'
	036 Campaign Frequency	'single campaign'
Solution		
5. Campaign Design	038 SP Theme	'news & current events, sports & entertainment'
	039 SP Technique	'cash-refund (long-term)'
	041 SP Support	'advertisement, free publicity, in-store/ POS promotion material, mailing'
	044 SP Design Restrictions	'legal issues'
	048 Risk Insurance	'yes'
6. Campaign Execution	045 Executive Agency	"Saatchi & Saatchi"
	047 Planned Running Time	'1 week – 1 month'
Outcomes		
7. Outcomes	049 Total Number of Respondents	'25000'
	054 Customer Information	'yes'
	062 Competitive Reaction:	'imitation promotion, lawsuit'
	064 Product/ Brand Sales	'major increase'

Table 2 **Summary of the data-collection procedure**

Data-collection Procedure
1. Student teams receive the assignment and can use the CBR-system for two days.
2. Student teams hand in their solution, together with a short questionnaire with data on the decision process and attitudes.
3. Students fill in the Hellriegel and Slocum (1992) checklist on thinking styles and motivation.
4. The solutions of the student teams are sent to the two SP-experts and the executive manager of the FMCG-company for evaluation on creativity and usability, respectively.
5. Students finish the course and receive their grade for the SP-assignment

Table 3 **Decision-maker Characteristics: Alpha Factor Analysis with Promax Rotation**

Scale Items / **Structure Matrix [a]:**	***Factor 1 (DTS)***	***Factor 2 (MSCP)***	***Factor 3 (CTS)***
Divergent Thinking Style (DTS)			
1. I consciously attempt to use new approaches toward routine tasks.	***.93***	-.40	
2. I seek many ideas because I enjoy having alternative possibilities.	***.72***		.53
3. When solving problems, I attempt to apply new concepts or methods.	***.64***		
Motivation to Solve Challenging Problems (MSCP)			
4. I always give a problem my best effort, even if it seems trivial or fails to arouse enthusiasm. [b]	-.42	***.81***	-.49
5. In the past, I have taken calculated risk and I would do so again.		***.67***	
6. I try to make an uninteresting problem stimulating. [b]	-.43	***.50***	
Convergent Thinking Style (CTS)			
7. I feel the excitement and challenge of finding a solution to problems.			***.74***
8. I know how to simplify and organize my observations.			***.53***
Factor Correlation Matrix			
Factor 1	1.00		
Factor 2	-.34	1.00	
Factor 3	.43	-.24	1.00
Cronbach's Alpha	**0.80**	**0.68**	**0.57**
Explained Variance			**70.3%**

[a] factor loadings < 0.40 are not shown.
[b] reverse-scored item
n = 34

Table 4 **Perceived Usefulness: Principal Components Analysis**

Scale Items	***Factor* (PUC)**
Perceived Usefulness of the CBR-system (PUC)	
1. Using the CBR-system made it easier to design the SP-campaign.	***0.97***
2. Using the CBR-system increased my productivity.	***0.97***
3. Using the CBR-system enabled me to design the SP-campaign more quickly.	***0.94***
4. I found the CBR-system useful for designing a SP-campaign.	***0.90***
5. Using the CBR-system enhanced my effectiveness.	***0.86***
6. Using the CBR-system increased the quality of the SP-campaign.	***0.76***
Cronbach's Alpha	**0.96**
Explained Variance	**84.2%**

[b] reverse-scored item
n = 17

Table 5a Regression Results for CBR-system Usage

	CBR-system Usage Time		
Independent variables	betaweight	t-value	tolerance
Decision-Maker Characteristics			
• Divergent Thinking Style	-0.16	-0.697	0.75
• Convergent Thinking Style	-0.43**	-1.802	0.71
• Perceived Usefulness	0.39**	1.806	0.86
	$R^2_{adj} = 0.36$	F = 4.055	(*p* = 0.031)

* p < 0.10; ** p < 0.05; 1-tailed
n = 17

Table 5b Regression Results for CBR-system Usage

	Perceived Impact of the CBR-system		
Independent variables	betaweight	t-value	tolerance
• Perceived Usefulness	0.58**	3.413	0.77
• CBR-system Usage Time	0.38**	2.239	0.77
	$R^2_{adj} = 0.64$	F = 15.451	(*p* = 0.000)

* p < 0.10; ** p < 0.05, 1-tailed
n = 17

Table 6a Regression Results for Solution Quality

Independent variables	Solution Creativity [a]		
	betaweight	t-value	tolerance
CBR-system Usage			
• CBR-system Usage Time	-0.31**	-1.826	0.90
Interaction term			
• Divergent Thinking Style x CBR-system Usage Time	0.32**	1.960	0.96
Decision-Maker Characteristics			
• Divergent Thinking Style	-0.26	-1.529	0.89
• Motivation to Solve Challenging Problems	0.17	1.013	0.94
• Judge Dummy	0.27	1.668	1.000
	$R^2_{adj} = 0.15$	$F = 2.185$	(*p* = 0.084)

* $p < 0.10$, ** $p < 0.05$; 1-tailed
[a] all continuous independent variables are mean-centered, due to the inclusion of an interaction term (following Irwin and McClelland 2001)
n = 34

Table 6b Regression Results for Solution Quality

Independent variables	Solution Usability		
	betaweight	t-value	tolerance
Solution Creativity	0.60**	2.891	0.87
CBR-system Usage			
• Perceived Impact of CBR-system	0.13	0.594	0.78
Decision-Maker Characteristics			
• Convergent Thinking Style	0.03	0.123	0.84
• Motivation to Solve Challenging Problems	0.40**	1.915	0.85
	$R^2_{adj} = 0.41$	$F = 3.805$	(*p* = 0.032)

* $p < 0.10$, ** $p < 0.05$; 1-tailed
n = 17

Table 7 **Summary of the results**

Hypothesis	***Expected Sign***	***Conclusion***
CBR-System Usage		
1. Overall Solution Quality		
H1: CBR-system Usage versus Non-Usage	+	Supported.
2. CBR-system Usage Time		
H2a: Divergent Thinking Style	+	Not supported.
H2b: Convergent Thinking Style	-	Supported.
H2c: Perceived Usefulness	+	Supported
3. Perceived Impact of Using the CBR-system		
H3a: CBR-system Usage Time	+	Supported.
H3b: Perceived Usefulness	+	Supported.
Solution Quality		
4. Solution Creativity		
H4a: CBR-system Usage Time	+	Not supported.
H4b: Divergent Thinking Style X CBR-system Usage Time (interaction effect)	+	Supported
H4c: Divergent Thinking Style	+	Not supported
H4d: Motivation to Solve Challenging Problems	+	Not supported
5. Solution Usability		
H5a: Solution Creativity	+	Supported
H5b: Perceived Impact of CBR-system	+	Not supported
H5c: Convergent Thinking Style	+	Not supported
H5d: Motivation to Solve Challenging Problems	+	Supported

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