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SYSTEMATIC INNOVATION IN SERVICE DESIGN THROUGH TRIZ

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ABSTRACT

This paper proposes an innovative service design approach by integrating the Theory of Inventive Problem Solving (TRIZ) into the conceptual design activities of current service development practice. Service design is considered to be one of the pivotal components in New Service Development (NSD) process which has a significant impact on downstream NSD activities such as project selection and market testing. Despite the recognized importance of service design, there is a lack of a systematic and effective problem solving process that covers all service design activities. To address this gap, we develop a systematic approach to service design based on TRIZ methodology. Also, we provide a case example to demonstrate the effectiveness of using this method in service context, and further illustrate some implications through the managerial perspective.

Keywords: Service Design, TRIZ, Systematic Innovation

INTRODUCTION

A recent debate on the issue of NSD centers on whether successful new services come about as a result of intuition, personal fancy, or inspiration (Langeard et al, 1986; Gummesson, 1989; Edvardsson, et al., 1994), or are more likely the outcomes of a formal development process (Sheuing, et al., 1989; Martin, et al., 1993). To address this issue, more research findings must be obtained to validate the arguments from either side of the discussion. This research project is designed to make an attempt to contribute this discussion. By focusing on service design, we try to develop a formal approach which is helpful for service developers to plan and control design activities and generate innovative concepts for new service offerings in a systematic manner. The realization of this objective would be helpful to make it true for the scenario of systematic innovation in the domain of service development.

LITERATURE REVIEW

In this section, a summary of literature review on service design is presented. In particular, we examine previous studies on the definition of service design and the tools used in service design.

Definition of service design

To date there is no widely agreed definition of service design in the literature. Service design is defined in ISO 9004-2:1991(E) as a process that involves converting the service brief into specifications for both the service and its delivery and control, while reflecting the organization's options (i.e. aims, policies, and costs)". Other definitions vary from "the idea to design high quality into the service system from the outset, and to consider and respond to customers' expectations in designing each element of the service" (Zeithaml et al., 1990), to "the concretization of the service concept in drawing flowcharts" (Gummesson, 1991). In differentiating service design from service development, Johnson et al. (2000) argue that service design emphasizes on specifying the detailed structure, infrastructure, and integration content of a service operations strategy, while NSD focuses on the overall process of developing service offerings. Through the review, it is noted that no matter what interpretations for service design are, service design is agreed to be crucial to the overall service development process.

Problem solving tools in service design

Much research in service design has focused on the tools used in the design activities of the overall NSD process (Johnson et al., 2000). However, many of the service design tools are analytical in nature, with limited abilities in resolving problems and overcoming pitfalls identified in the design process. One example is the use of quality function deployment (QFD) in service design. QFD is very useful in identifying problems in the course of service design, such as identifying contradictory relationships among different service product attributes (Rovira et al., 1998). However it often can not suggest effective solutions to eliminate the contradictions without making compromises between conflicting requirements. Another example is the root cause analysis (RCA) which is often used in identifying potential service failure points. The preventive solutions are mainly generated based on the past experience of designers rather being provided by RCA. Moreover, since RCA is closely allied to the optimization of existing process (Mann, D., 2002), if service designers rely wholly on the outcome of its analysis, it would be very difficult to find innovative breakthrough solutions.

Therefore, we believe that service design is in the need of a set of problem solving tools which can help to address identified design problems. In the following sections, an approach to service design is presented by introducing TRIZ into the conventional practices of service design.

CONCEPTUAL FRAMEWORK

Based on the literature review on service design, service development and TRIZ, we propose a new approach to systematic service design by using TRIZ. TRIZ is a creativity method which can be actually described as a structured problem solving process with the integration of a set of problem definition and resolution tools that were created on the basis of the analysis of millions of world-wide patents. With several decades of development and practices, TRIZ has already proven its effectiveness and efficiency in resolving technical problems for physical product design (Altshuller, 1997; Terninko et al., 1998; Rantanen et al., 2002). Due to the universality and capability of TRIZ techniques, more and more TRIZ researchers have realized the potentials of extending TRIZ applications to non-technical problems. As one of the non-technical areas, service development has shown the promise to be integrated with TRIZ. By applying TRIZ to the service context, we introduce a new way of succeeding in service design - one that is able to achieve systematic innovation through resolving innovative problems with formalized tools and steps.

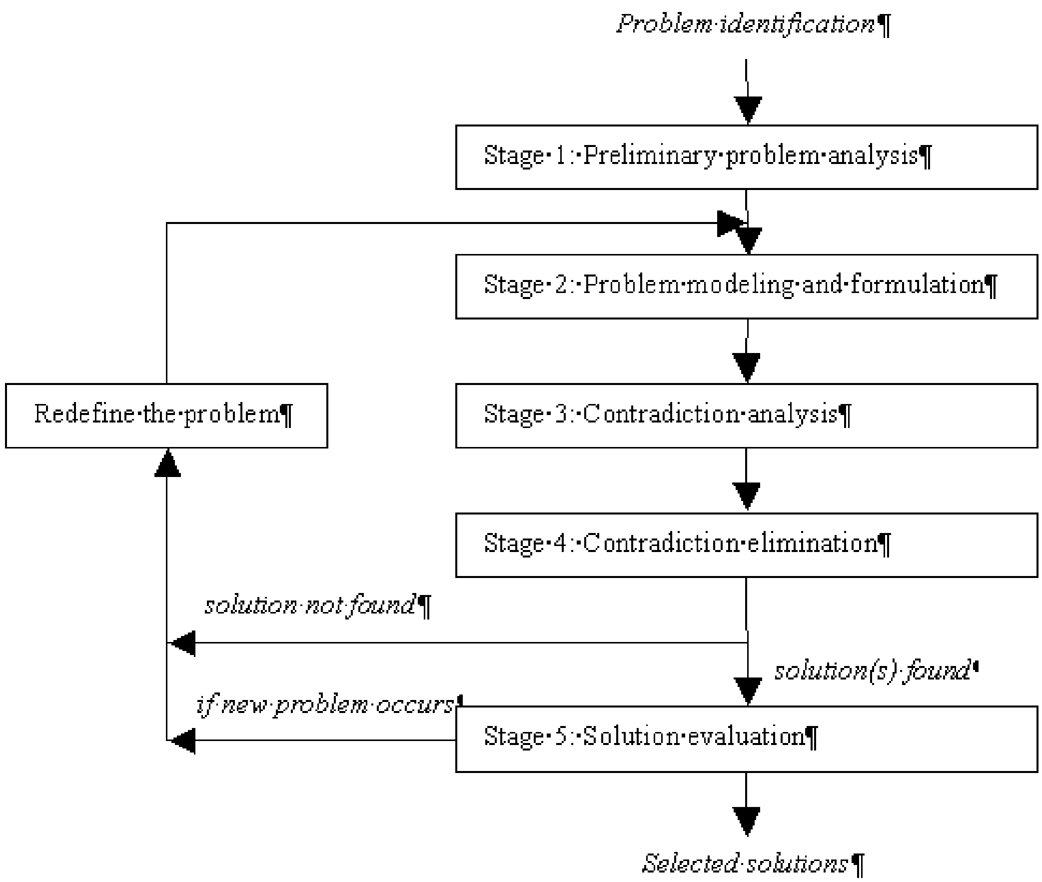

Figure 1 - Using modified TRIZ problem solving process in service design

As shown in Figure 1, the conceptual framework comprises of five main stages which basically follows the classical TRIZ problem solving process (see Domb, 1998). The initial input to the entire process is a list of identified problems from service operations. At stage one and two, these original problems are defined with the language of TRIZ in order to provide insightful information for further problem solving. After problem definition, the problems are structured into typical TRIZ contradictions by using contradiction analysis. At stage four, some TRIZ problem resolution tools are employed to eliminate the formulated contradictions. The generated ideas are evaluated by using the unique TRIZ criteria of ideal final result (IFR). The final output after the stage of solution evaluation should be a pool of innovative conceptual solutions to service design, which are ready for the further sorting and refinement in downstream NSD activities. If solutions are still not found after contradiction elimination, or some other new problems occur after solution evaluation, the problem solving process must be iterated back to the first stage to redefine the orginial situation. In the following paragraphs, we describe the five stages to more details.

Stage 1: Preliminary problem analysis

The objective of this stage is to identify and collect existing problems in service operations, and then conduct some analysis to capture the information of the problem situation. Table 1 is used to perform the analysis. It consists of a set of questions which are to be answered. These questions are designed to help service designers to better understand the in-depth situation of the original problem. Detailed answer of the questions will be very helpful to stimulate the generation of innovative solutions in the following problem solving stages.

Table 1 - Preliminary Problem Analysis

Questions and Descriptions
1. What is the purpose of the target service? Hint: Describe what are the (potential) customer needs to be met, and how does the current problem service, or desired new service aim to meet the needs
2. What is the existing problem? Hint: Describe briefly the existing problem in service operations system
3. What are the known solutions? Hint: State the past and current solutions to resolve the identified problems, remove barriers, or improve/refine the situation
4. What are the pros and cons of the known solutions Hint: Analyze both the advantages and disadvantages of the above stated solutions
5. What is the system structure of the target service operations? Hint: Identify the subsystems or any components of the target service operations system, and then specify the relationships among the components
6. What is the ideal final result to the original problem ? Hint: Formulate the possible ideal solutions that deliver all of the benefits without compromising with any harmful elements, and require no costs to solve the problem
7. What are the local constraints or limitations? Hint: Estimate the permissible expenditure for solving the problem, and find out the allowable and not allowable changes to the original system
8. What is the objective for this problem solving project? Hint: Set the project objective of the problem solving in service design *(A typical objective of TRIZ problem solving is to eliminate the harmful elements in the system without introducing new problems, and/or deteriorating the original system.)*

Stage 2: Problem modeling and formulation

Based on the analysis of the problem situation, further problem modeling and formulation can be done by using the TRIZ technique of Problem Formulator (PF) (see Zlotin et al., 2001). The purpose of problem modeling is to build a function diagram by using function analysis, while problem formulation is to formulate an exhaustive set of problem statements on the basis of the function diagram.

The process of building function diagram starts with the identification of basic function components, and follows by specifying the relationships between these functions. Function identification can be done by asking what the service does for consumers (Berkeley, 1996). Problem formulation classifies system functions into two types: harmful functions and useful functions. The identified functions are connected with each other in the form of a network of cause-and-effect relationships.

The second step is to formulate problem statements based on the function diagram. Formulating problem statements makes solution generation more explicit because the relationships between functions are more easily observed than in a traditional single problem structure (Terninko et al., 1998). A complex problem is thus decomposed into a series of correlated small problems which are easier and more straightforward to be solved. Very often, after this stage of analysis, some solutions or at least some indications to possible solutions can be obtained through analyzing problem statements.

Stage 3: Contradiction analysis

PF has been shown to be effective in analyzing and generating preliminary results for those problems which can be expressed in simple function diagrams. However, if the situation is complicated, the building of a function diagram would be very time-consuming. This will also probably result in a set of lengthy problem statements which will turn out to be very costly to analyze one by one. In this case, an alternative way to analyze problems is to identify one or just a few of key problems (inherent contradictions), which are behind many other superficial problems within the same system. The elimination of the inherent contradictions will usually lead to the resolution of the superficial problems at the same time.

The purpose of structuring an inventive problem into the form of a contradiction is to identify two conflicting components (either subsystems or functions) in the original system, or two opposite requirements to the same element/condition of the system. Sometimes, contradictions can be found by analyzing problem statements (Terninko et al., 1998; Zlotin et al., 2001), defining the Tool-Object-Product in the system (Royzen, 1999), or simply using the TRIZ technique of root contradiction analysis (Mann, D., 2002).

After formulating the inherent contradiction, an efficient method to analyze the conflicting scenario before applying the formal principles is to intensify the two conflicting aspects of the contradiction to two extreme situations (Rantanen et al., 2002). Sometimes some insightful indications of solving the problems may surface by using this method.

Stage 4: Contradiction elimination

To eliminate formulated contradictions effectively, TRIZ provides a set of powerful tools and principles, such as ARIZ, 40 inventive principles and Contradiction Matrix, etc. Among them, the 40 inventive principles and the 4 separation principles (separation in space, separation in time, separation between the whole and its parts, and separation upon conditions) are considered one of the most accessible and useful TRIZ problem resolution techniques. Practical applications have proved that these principles are not only effective in eliminating contradictions in technical problems (Altshuller, 1997), but also they are equally effective in handling non-technical problems (Mann et al., 1999; Terninko, 2001; Retseptor, 2003; Hipple, 1999). The two examples as follows are used to illustrate the efficacy of using some of these principles in the context of service industries. They demonstrate that the adoption of appropriate principles is even effective and efficient in deriving innovative strategies to eliminate contradictions in service design problems.

Example 1: Use of "extraction" and "self-service" principles in developing banking services.

Before the emergence of Automatic Teller Machine (ATM), people had to go to bank for even simple transactions such as cash withdrawal and funds transfer, and suffered from unexpected waiting time. On the side of banks, they always found it costly to handle each of the routine transaction manually. By extracting the core functions which essentially perform the transactions in the course of service delivery and then standardizing them, ATM offers a breakthrough solution to solve the contradiction of "customers had to be present in person at bank in order to withdraw cash, customers should not be present because of extreme inconvenience". In fact, the use of credit card as one of the important payment modes and the recent introduction of internet banking services all the way follow the same innovation pattern, that is, extracting the functions performing the transactions out of physical banks and make them happen as close as possible to customers. Moreover, the adding of customer self-service concept into the delivery system of banking services also lowers the transaction cost for the bank.

Example 2: Use of "cushion in advance", "separation in time", "mechanical vibration" and "periodic actions" principles to manage service capacity and demand.

Many service industries, such as hospitals, cinemas, and hotels, face a common contradiction, that is, service capacity must be big enough to smooth customer demand and make more profit, however, service capacity must be limited to a certain level because customer demand always varies with time, and extra capacity perishes without demands and thus incurs huge cost. By using the principles of "cushion in advance", "separation in time", "mechanical vibration" and "periodic actions", some strategic decisions can be derived to smooth the demand or vary service capacity with customer demands. The examples are using price differentials to encourage off-peak demand, advertising early to avoid seasoning rush, using appointments and reservations, or employing part-time staff to enhance service capacity temporarily.

Stage 5: Solution evaluation

After eliminating the contradictions, a pool of solution ideas should be generated. Since ideas are just generated before this stage and have not yet been conceptualized in context, it is more desirable to protect them at their most fragile stage than to kill them. Thus, the main purpose of this evaluation is to identify which are the best ideas based on the yardstick of ideality. The technique used frequently in solution evaluation is called ideal final result (IFR). IFR is an implementation-free description of the situation after a problem has solved (Domb, 1997). An ideal solution is the one which delivers all of the desirable benefits without harm, and requires no cost to solve the problem. After formulating IFR, the work of solution evaluation can be done by checking whether the generated ideas are against the law of ideality. The best solution should be the one closest to the state of ideality.

Downstream developments

The final output from this framework would be some selected innovative service concepts. Further work must be done before making decision on solution selection, such as concept development and testing, preliminary market and business analysis, etc. The obtained quality service concepts would offer a wide range of viable options which can be helpful to substantiate the initiation of new service projects.

A CASE EXAMPLE

A case example is provided to improve the car entry system in a family resort island in Singapore known as Sentosa Island. The proposed service design method is used to analyze and eliminate the side-effects resulted from the increased number of entry cars.

Case background (Ref: Teo, Nov., 6th, 2002, The Straits Times)

In order to attract more visitors and to silence those who complain about its high admission charges, the Sentosa Development Corporation (SDC) changed its vehicle-entry system in Nov. 2002. Under the new scheme, a visitor driving in pays $2 for individual entry and $2 for parking. This does away with the old drive-in, night entry and late-night entry schemes, which had car owners paying anything from $6 to $15 to drive to the island at various times. However, while this move caters to the needs of some visitors, it also causes some serious environmental issues that might reversely affect the brand image of Sentosa Island. Facing on this situation, how could SDC take effective measures to resolve the arising problems caused by the change of car entry policy? By using TRIZ, it is possible for us to systematically find some effective solutions to address the situation.

Stage 1: Preliminary problem analysis

The direct impact of lowering car entry fee is that an increasing amount of local people who own cars come to Sentosa more often than before. It is especially welcomed by local family who drive to the island in a car. However, the increased number of cars also bring with some negative outcomes as follows:

- Potential danger to walkers and cyclists caused by some vehicles driven at high speeds.
- The quietness on the island is disturbed by the hustle and bustle of mainland life which is brought by the increased number of cars.
- Unpleasant sights caused by some randomly parked vehicles near the beach.
- When more roads and car parks are paved to cater to the increasing number of motor vehicles coming onto the island, lush forests may be paved over
- Air quality may be affected. Thus the increased pollutants in the air might as well affect the fauna, flora and even the dolphins at the bay.
- The increasing traffic jam problem to Sentosa.

The system regarding the situation of this problem consists of the sub-systems such as visitors, cars, operation staff, SDC, and the resource (facilities, operational staff, natural surroundings, etc) on the island. The ideal solution should be helpful to eliminate all of the problems above while still keep the advantage of attracting visitors, and not introducing new problems. The objective for this case is to find effective solutions to eliminate the side-effects resulted from the policy of lowering car entry fee while not deteriorating the original system.

Stage 2: Problem modeling and formulation

A function diagram of the target cycling problem is presented in Figure 2 on the basis of the obtained information through preliminary problem analysis. The construc tion of this diagram starts with the primary useful function (PUF), which is to attract more tourists to visit Sentosa Island, so that SDC could establish its brand image in the Singapore leisure industry. The useful function (UF) of improving of the accessibility to the Island would be one of the effective strategies to realize the PUF. For this aim, SDC issued the new policy of "lowering car entry fee" (UF) in order to attract the local people to come to the Island more frequently. This measure would certainly help to eliminate the harmful function (HF) that the past negative perception of driving to Sentosa Island was inconvenient and expensive. However, it also brought new problems to the Island environment (HF).

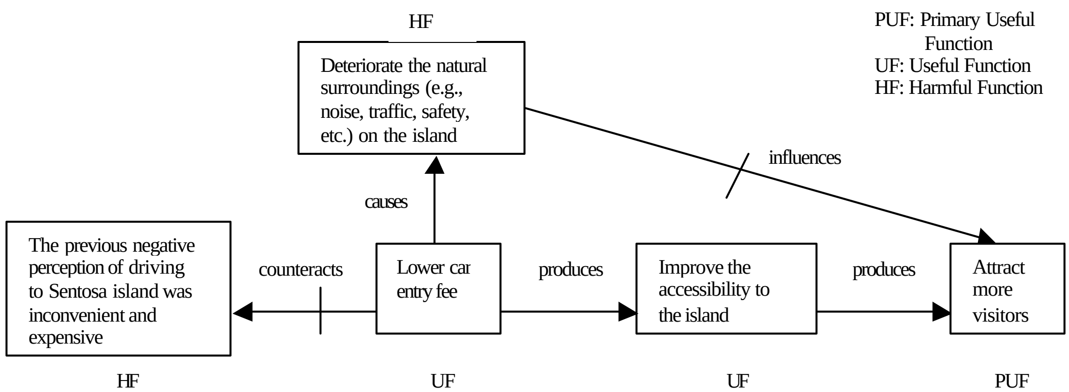

Figure 2: The functional diagram used to analyze the effects resulted from lowering car entry fee to Sentosa Island

According to the constructed function diagram, a total number of eleven problem statements as follows are formulated.

1) Find an alternative way to obtain [Attract more visitors] that does not require [Improve accessibility to the island] and is not influenced by [Deteriorate the natural surroundings]
2) Find a way to enhance the effectiveness of [Attract more visitors].
3) Find an alternative way to obtain [Improve the accessibility to the island] that provides [Attract more visitors] and does not require [Lower car admission fee]
4) Find a way to enhance the effectiveness of [Improve the accessibility to the island].
5) Find an alternative way to obtain [Lower car entry fee] that provides [Improve the accessibility to the island] and counteracts [The previous perception of driving to Sentosa was inconvenient and expensive], and does not cause [Deteriorate the natural surroundings].
6) Find a way to enhance the effectiveness of [Lower car entry fee].
7) Find a way to resolve the contradiction that [Lower car entry fee] should be in place in order to provide [Improve the accessibility to the island] and conteract [The previous perception of driving to Sentosa was inconvenient and expensive], but should not exist in order not to cause [Deteriorate the natural surroundings].

8) Find a way to eliminate, reduce or prevent [The previous perception of driving to Sentosa was inconvenient and expensive] that does not require [Lower car entry fee].
9) Find a way to benefit from [The previous perception of driving to Sentosa was inconvenient and expensive].
10) Find a way to eliminate, reduce or prevent [Deteriorate the natural surroundings] in order to avoid influencing [Attract more visitors] under the condition of [Lower car entry fee].
11) Find a way to benefit from [Deteriorate the natural surroundings].

The analysis of problem formulations can give some indications, among which some of them are insightful, while others may not be practical. The following indications are derived through the analysis on the formulated eleven problem formulations:

- Find alternative ways to attract visitors to the Sentosa Island instead of lowering car entry fee (e.g., update old attractions and develop new ones, improve service quality, design and provide more innovative service programs)
- Provide more low cost options for visitors to entry with convenience (e.g., free bus, cable car, ferry, cycling, etc.)
- Find alternative ways to lower car entry fee (e.g., provide free car park space outside the Island)
- Improve the transport system to the Island, therefore make it convenient to visit it (e.g., Extend the city subway system to the Island)
- Find ways to prevent the natural surroundings from the impacts from the increased car entries (e.g., underground car entry and park)

Stage 3 & 4: Contradiction analysis and elimination

From the perspective of contradiction analysis, the situation could be interpreted as a service capacity problem, because it is hard to accommodate so many entry cars at the same time. So one of the inherent contradictions in this situation could be formulated as that all of the entry cars should be accommodated in order to be in line with the policy of lowering car entry fee, however it is hard to accommodate so many cars because of the limited capacity and a series of negative impacts resulted from the increased number of car entries. To resolve this contradiction, we can firstly intensify the contradiction to two extreme situations, that is, "many cars" versus "few cars". The "many cars" extreme means that all of the cars can be allowed to entry and well-accommodated. The "no car" extreme means that the entry cars should be separated from the natural surroundings on the Island. Based on the indications from the two extreme situations, and the analysis on certain separation principle and inventive principles, some possible solutions can be formulated as follows:

1) *Principle of Separation in Space:* Build underground car parks to provide more space for the increased car entries.
2) *Principle of Porous Materials:* Open a special way for car entry (e.g., a sea tunnel linking the mainland road with the underground car parks on the island). This approach can decrease the damage from car noise and gas pollutants to the lowest level.

3) *Principle of Thermal Expansion:* Extend the mainland SMRT (train) system to the Island. This will make it very convenient to visit the Island and reduce the amount of entry cars.
4) *Principle of Segmentation & Merging:* Customers should be segmented on the basis of their needs. Thus a combined set of strategies should be adopted to provide multiple access options for visitors who own cars and those who do not own cars.

Stage 5: Solution evaluation

A list of possible ideas to address the car entry problem are formulated through the analysis from stage one to stage four. According to the ideal final result, if it is possible to open a special channel for car entry, then this concept would be closest to the state of ideality. It is because this solution can help to eliminate almost all of the problems appearing in the situation without introducing more serious problems. The example of constructing sea tunnel might be very costly. So a cheaper and lower cost alternative would be more acceptable to address this situation. Another important point is that there are still many visitors not preferring driving to the Island. To cater to the needs of different visitors, more other access options should be provided. A convenient and efficient access means (e.g., SMRT system) will be very attractive to visitors. This might also help to reduce the amount of cars. Therefore, a combined set of effective strategies might be needed to build a sufficient final solution to address the original situation.

Summary

This case example illustrates the effectiveness of applying TRIZ in service design. By following the proposed design process, we found out a list of possible solutions which might be useful to address the situation faced by SDC. Before adopting any of these design solutions, further work needs to be done to analyze the business and market feasibilities, and then implement them into the context of the Sentosa Island.

MANAGERIAL IMPLICATIONS

The implementation of this new method in NSD process would be beneficial to service firms in many managerial aspects. First, as a formalized approach, this method can help service companies to get rid of the previous not systematic practices in developing new services. It thus shortens the development cycle. And in turn, this may lead to savings in development time and cost, and the overall time-to-market. Second, since this method is based on the nature of efficient problem solving, it can play the role as a fast remedy system for service recovery in case organizations meet service failures. Third, having a powerful knowledge base which consists of a collection of innovation patterns, TRIZ can help practitioners to develop new services in the first place by avoiding reinventing the wheel. In fact, service organizations can further enhance the effectiveness of the knowledge base by collecting the best service innovation examples across different industries.

CONCLUSION

This paper proposes a new way of applying TRIZ to the domain of service industries. Since the foundation of the classical TRIZ is based on the extraction of technical data, it may not be able to reflect all of the distinct innovation patterns in non-technical areas. Therefore, at this very beginning stage of introducing TRIZ to service industries, we emphasize more on the nature of systematic thinking in problem solving. We believe that, however, the effectiveness of using TRIZ in service domain can be further enhanced. This can be done by incorporating more the information of the best practices in service industries into the TRIZ knowledge-base.

REFERENCES

Altshuller, G. S. (1997), *40 principles: TRIZ keys to technical innovation*, translated and edited by Shulyak, L., Rodman, S., Technical Innovation Center, Worcester, MA.

Berkley, B.J. (1996), "Designing services with function analysis", *Hospitality Research Journal*, Vol. 20, No. 1, pp. 73-100.

Domb, E. (1997), "The ideal final result: Tutorial", *The TRIZ Journal*, Feb issue, http://www.triz-journal.com/archives/1997/02/a/index.html.

Domb, E. (1998), "QFD and TIPS/TRIZ", *The TRIZ Journal*, June issue, http://www.triz-journal.com/archives/1998/06/c/index.htm

Edvardsson, B., Thomasson, B., Øvretveit, J. (1994), *Quality of service: Making it really work*, McGraw-Hill Book Company, London.

Gummesson, E. (1989), "Nine lessons on service quality", *The Total Quality Management Magazine*, Vol. 1, No. 2, pp. 82-90.

Gummesson, E. (1991), *Qualitative methods in management research*, Sage Publications, Newbury Park, CA.

Hipple, J. (1999), "The use of TRIZ separation principles to resolve the contradictions of innovation practices in organizations", *The TRIZ Journal*, August issue, http://www.triz-journal.com/archives/1999/08/a/index.htm

Johnson, S.P., Menor, L.J., Roth, A.V., Chase, R.B. (2000), "A critical evaluation of the new service development process: Integrating service innovation and service design", in Fitzsimmons, J.A., and Fitzsimmons, M.J. (Eds.), *New Service Development: Creating memorable experiences*, Sage Publications, Thousand Oaks, CA.

Langeard, E., Reffiat, P., Eiglier, P. (1986), "Developing new services", in VenKantesan, M., Schmalensee, D.M. and Marshall, C. (Eds.), *Creativity in services marketing: What's new what works, what's developing*, American Marketing Association, Chicago, IL.

Mann, D., Domb, E. (1999), "40 inventive (business) principles with examples", *The TRIZ Journal*, Sept issue, http://www.triz-journal.com/archives/1999/09/a/index.htm

Mann, D. (2002), "Analysis paralysis: When root cause analysis isn't the way", *The TRIZ Journal*, May issue, http://www.triz-journal.com/archives/2002/05/b/index.htm.

Martin, C.R. and Horne, D.A. (1993), "Services innovation: Successful versus unsuccessful firms", *International Journal of Service Industry Management*, Vol. 4, No. 1, pp. 49-65

Rantanen, K., Domb, E. (2002), *Simplified TRIZ: New problem-solving applications for engineers and manufacturing professionals*, ST. LUCIE PRESS, Boca Raton, FL.

Retseptor, G. (2003), "40 inventive principles in quality management", *The TRIZ Journal*, March issue, http://www.triz-journal.com/archives/2003/03/index.htm

Rovira, N.L., Aguayo, I.H., (1998), "A new model of the conceptual design process using QFD/FA/TRIZ", *The TRIZ Journal*, July issue, http://www.triz-journal.com/archives/1998/07/d/index.htm

Royzen, Z., (1999), "Tool, Object, Product (TOP) Function Analysis", *The TRIZ Journal*, July Issue, http://www.triz-journal.com/archives/1999/09/d/index.htm

Sheuing, E., Johnson, E. (1989), "A proposed model for new service development", *Journal of Services Marketing*, Vol. 3, No. 2, pp. 25-34.

Teo, G. (2002), "Would you go to Sentosa now?", *The Straits Times*, Nov., 6th, 2002, Singapore Press Holdings, Singapore.

Terninko, J., Zusman, A., Zlotin, B. (1998), *Systematic innovation: An introduction to TRIZ*, St. Lucie Press, Boca Raton, FL.

Terninko, J., Zusman, A., Zlotin, B. (2001), "40 Inventive Principles with Social Examples", *The TRIZ Journal*, June issue, http://www.triz-journal.com/archives/2001/06/a/index.htm.

Zeithaml, V.A., Berry, L.L., Parasuraman, A. (1990), *Delivering quality service: Balancing customer perceptions and expectations*, Free Press, NY.

Zlotin, B., Zusman, A. (2001), *Directed Evolution: Philosophy, Theory and Practice*, Ideation International Inc., Southfield, MI.