Applying TRIZ to Service Conceptual Design: An Exploratory Study

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This paper introduces a new avenue for applying the Theory of Inventive Problem Solving (TRIZ). TRIZ tools may be used in designing new service concepts in the field of new service development (NSD). Up to the present time, the practice of generating new ideas in NSD has been dependent largely on inspiration, luck and flair. One shortcoming in the generation of creative ideas is the psychological inertia or mental block commonly encountered. This research proposes to use TRIZ to help spawn new and perhaps unorthodox ideas and concepts in NSD. A case study on canteen operation demonstrates the feasibility of applying TRIZ in service design.

Introduction

With the shift from manufacturing to services, the issue of new service development (NSD) has grown in importance. Companies such as General Electric, Xerox and Hewlett Packard, which until a few years ago generated a majority of their profit from selling physical products, are rapidly transforming themselves into service providers. To remain competitive in the service market, companies actively seek creative ways to generate new service concepts that can meet customer needs.

Service design is distinct from the development of physical products due to characteristics such as customer participation, perish ability, intangibility and heterogeneity. These characteristics collectively impact service development and make it more challenging than physical product development. It is, thus, of no surprise that the art of service development has tended to be ad hoc and haphazard in nature (Metters, King-Metters and Pullman, 2003). In response, NSD researchers have developed processes such as the stage-gate product development process (Cooper, 2001). A number of NSD process models have been proposed in the last decade. However, as observed by Johnson et al. (2000) and Bowers (1989), most of the existing NSD process models ignore the unique characteristics of services, and are based mainly on a small number of new product development processes. Johnson et al. (2000) further argued that little empirical work exists to validate the processes across different service industries.

Recent studies showed that one of the weakest activities in a typical NSD process is idea generation. Although idea generation is a pivotal pre-development activity, it has not been addressed adequately by researchers (Bowers, 1989; Edgett, 1996; Kelly & Storey, 2000). Service developers have tended not to engage in formal ways of idea generation (Easingwood, 1986). Instead they rely largely on the experiences of front-line staff or customers. One consequence has been that the quality and innovation levels of new ideas are severely affected because of the psychological inertia inherent in human thinking. The tendency is to focus on what is known (i.e. along the assumed search direction), thereby keeping the solver from the right solution (Savransky, 2000). To overcome this limitation, one solution is to identify and establish a systematic and operational mechanism in idea generation. Menor, Tatikonda and Sampson (2002) discussed that more studies have to be done on the operational tools employed for successful NSD. Johnston (1999) argued for the development of good design tools and techniques in NSD. This paper proposes an approach to new service development through the use of TRIZ.

Literature Review

In this section, a literature review is presented in the following three areas: (i) new service development; (ii) service design tools; and (iii) TRIZ.

New Service Development

Traditionally, new service development processes were rather informal and employed ad hoc procedures (Metters et al., 2003). As a result of the intangibility of services, providers find it difficult to control and measure the specification or quality of services before launch. For this reason, service companies tend to revamp service development processes in their own ways. As a result, many service developers would rather believe that new services came about as a result of intuition, personal fancy or inspiration (Gummesson, 1989; Langeard, Reffiat & Eiglier, 1986).

However, several researchers holding the opposite view argue that new services are more likely the outcome of formal development processes (Bowers, 1989; Martin & Horne, 1993; Sheuing & Johnson, 1989). A number of NSD process models have been proposed in the last decade. Johnson et al. (2000) reviewed and classified NSD process models into the following three categories: partial models, translational models and comprehensive models. The results of the exploratory research in formalizing NSD is beginning to convince many people that the process of NSD can be as systematic as that of new product development (NPD).

In between the above two opposing views, some researchers argue that services tend to use less formal NSD processes than those found in NPD (Griffin, 1997). The innovation and adoption of new services must be both a planned process and a happening (Edvardsson, Haglund & Mattsson, 1995). Although this discussion is still inconclusive up to now, recent findings have demonstrated that it is possible to increase the degree of formality in NSD processes. A good example for this is the NSD process cycle proposed by Johnson et al. (2000). Menor et al. (2002) considered their research to be crucial in increasing the speed and effectiveness of developing NSD competencies.

Service Design Tools

It is generally agreed among service researchers that a poor strategy is to depend totally on luck in developing new products (Zeithaml & Bitner, 2000). Indeed successful service firms have been found to sometimes adopt elaborate ways of developing services (Shueing & Johnson, 1989). In the previous decade, much effort had been put into formalizing NSD. Besides the proposition of formal NSD process models, service design tools, such as service blueprinting (Shostack, 1984), functional analysis (Berkeley, 1996), and structured analysis and design (Congram & Epelman, 1995), have also been developed to assist service designers in developing service concepts.

The limitations in existing service design tools to overcome psychological inertia in problem solving have severely affected both the amount and the quality of design solutions. The challenge is compounded by the ill-structured nature of design problems where often one or more steps (or states) are either unknown or incoherent. Furthermore, sufficient information concerning the initial state and the properties of the goal state are rarely fully specifiable in advance (Goldschmidt, 1997). Compared to methods such as brainstorming, lateral thinking, morphological analysis and mind mapping, Savransky (2000) argued that only TRIZ would be useful for solving difficult problems with unknown causes and unknown search directions. The knowledge-based toolkit provided by TRIZ is very effective in helping problem-solvers to overcome their own psychological inertia, which is considered the hardest part in solving difficult problems (Altshuller, 1984). Mann and Dewulf (2002) argued that in terms of its toolkit, method, strategy and philosophy, TRIZ is the most comprehensive of any available model. TRIZ has great potential to integrate with many innovation tools, such as six sigma, quality-function deployment and neuro-linguistic programming.

TRIZ

TRIZ is the Russian acronym for the Theory of Inventive Problem Solving. It was developed by Genrich Altshuller and his colleagues in 1946, in the former USSR. The hypothesis of TRIZ research is that if there are existing universal creativity principles that can be identified, codified and taught to people, the innovation process can be made more predictable. The grounding TRIZ research was done by way of analysing over two million patents worldwide, from the 1940s to the 1980s. Through this detailed work, a number of innovation patterns and laws of ideality were identified and extracted. The distinct features of TRIZ can be summarized as follows:

- it helps to generate many quality ideas in a systematic and efficient manner;

- it helps to overcome psychological inertia by formulating an exhaustive set of possible solutions;
- it encourages breakthrough thinking without trade-off or compromise.

With several decades of development and application, TRIZ has proven its effectiveness and efficiency in resolving technical problems for physical product design (Altshuller, 1997; Rantanen & Domb, 2002; Terninko, Zusman & Zlotin, 1998). In recent years, especially since the establishment of the *TRIZ Journal* in 1996, there has been greater interest in applying TRIZ to various other fields, such as NPD and technology management (Clausing, 2001; Ungvari, 1999), education and training (Marsh, Waters & Mann, 2002; Rivin, 1998; Schweizer, 2002), biology (Vincent & Mann, 2000), and business management (Mann &Domb, 2001; Ruchti & Livotov, 2001). The integration of TRIZ with other leading methodologies, such as quality function deployment (Domb, 1998; Schlueter, 2001; Terninko, 1998) and six sigma (Tennant, 2003; Verduyn, 2002) has also demonstrated strong potential.

Thus far the literature on applying TRIZ in services development has been limited (see Low et al., 2001 and Rantanen & Domb, 2002, for a review of possible applications of TRIZ in services). No systematic examination has been done to explore the use of TRIZ in resolving problems in service design and development.

The present research made modifications to several TRIZ tools. These were applied to resolve problems in a service context. By doing so, we introduced a new means of succeeding in service design – one that is able to achieve systematic innovation using formal tools and steps.

Theoretical Approach

As mentioned, TRIZ is useful in product design because of its unique method of problem resolution. In this section, the synergy between TRIZ and service problem solving is discussed, together with an explanation for how TRIZ would be useful in new service design and development.

TRIZ analyses problems through the unique perspective of contradiction. In technical areas, contradictions are relatively more tangible and easier to appreciate. Although service products are different from physical products, contradictions are also often found in services. Service contradictions may seem more intangible and abstract than those found in technical areas. Table 1 lists a few common service contradictions. Each of the contradictions is expressed briefly with key contradictory terms. For instance, the contradiction of 'standardization *versus* customization' used to be a common problem in service industries. With the introduction of computer technology that enabled individual personalization, the contradiction of mass customization is no longer unsolvable. Since TRIZ provides a powerful toolkit to separate contradictions without the need to compromise, it might be possible to use TRIZ to resolve service problems that have embedded contradictions.

The second synergy between TRIZ and services concerns the issue of innovation in service design. TRIZ has a very large knowledge base consisting of information abstracted from patent analysis. This information has been well instilled into the creation of several TRIZ tools, such as the 40 inventive principles, 4 separation principles, patterns of technological evolution and the 76 standard solutions. A parallel with innovation tools in service design can be drawn. For instance, Berry and Lampo (2000) identified the following five categories of service redesign: self-service, direct service, pre-service, bundled service and physical service. The comparison between these five service redesign patterns and TRIZ's 40 inventive principles reveal similarities in their concepts. The implication is that service innovation may be brought about by the use of an identified and codified innovation methodology. The NSD process can be made more predictable.

To substantiate the above point, Zhang, Chai and Tan (2003) collected numerous examples in service operations management. They found that the examples could be categorized into the original 40 inventive principles. Despite differences between goods and services, it was found that most of the inventive principles and their innovation patterns could be applied to the service sector. Zhang, Chai and Tan (2003) also found that an enhanced set of service innovation patterns could be developed to better portrait generic innovation patterning in the service sectors.

This research shows that with appropriate modification, TRIZ tools can be applied to resolve problems found in service development and operations. In the following section, an empirical case study is provided to verify the viability of using TRIZ to solve service problems. A study was conducted on restructuring the service operations of a university canteen. Several TRIZ tools, such as the problem formulator, root contradiction analysis and the 40 inventive principles, were applied with certain modifications. These were used to generate conceptual solutions to address the

Table 1. Common Contradictions in Service Industries

Service Contradiction	Description
Diversity *versus* Focus	Services targeted for mass market cater to the needs of a wide range of customers, but result in undifferentiated services. However, services targeted for a niche market cater for a certain segment of customer profile. They are not good for expanding market share by widening the range of customer needs.
Customization *versus* Standardization	Customizing service offerings according to the preferences of customer needs can attract and retain customers from a wide range. However, this will reversely lower the speed of service delivery. Delivery efficiency is one of the most important dimensions in measuring service quality.
Functionality *versus* Ease of use	Multi-functional e-services are powerful in problem solving for e-customers, but it increases the load of customers to figure out the usage of e-services.
General information *versus* Detailed information	General (guideline) information gives users general ideas and save them time in searching. But they do not tell the full story. Specific, concrete information is informative but less focused, simplified and difficult to browse.
Security/Privacy *versus* Transparency	Secure service ensures the safety of transaction and privacy of customer information, whereas customers are not well informed of the operation process of transaction. This lowers the trust of customers, and reduces further usage of the secure service. However, making the operation process transparent will reversely enhance the risk of losing confidentiality.
Industrialization *versus* Personalization	Customers receive convenient and swift online services (e.g. e-banking transaction, funds transfer). However, this self-service involves much less human interaction and naturally reduces customer loyalty, which is usually established by 'tangible' service (e.g. brick-and-mortar bank branches).

identified problems in the operation of the canteen system.

Case Study

The Techno Edge canteen is one of three major university canteens surveyed in this study. Typically, the food outlets in the canteen operate from 8.30 am to 6.30 pm on weekdays, and from 8.30 am to 2:00 pm on Saturdays. The canteen is closed on Sundays and public holidays. Since it is not convenient to purchase food elsewhere outside of the operation hours of the canteen, some students have requested an extension of the hours of operation. This solution, however, may not be welcomed by the food operators for reasons of cost ineffectiveness.

To capture the situation information, several questions from the innovative situation questionnaire were selected and modified (see Terninko, Zusman & Zlotin, 1998, for the original questions). These questions were used in our interviews with the food-outlet operators, operations staff and consumers. Some example questions are as follows:

1. What might be the possible solution(s) to the canteen operation hours problem?
2. What are the advantages and disadvantages of these solutions?
3. What might be the ideal solution to address the operation hours problem?

4. What are the local constraints to implement the solutions and resolve the operation hours problem?

Through an investigation of the canteen operations and interaction with the operations staff, information was obtained, structured and processed using TRIZ's tools and methods. The objective of the case study was to find effective measures to improve the operation of the canteen so that the dining needs of all customers can be met. The centre of the operations system is the targeted canteen, which includes all of the physical facilities, operators and other resources. The super-system over the canteen operations system is the entire university. To address this problem, the ideal solution should be able to eliminate all of the existing problems on both sides (both the customers and canteen operators) at as little cost as possible.

After gathering the interview information, the problem formulator was used to analyse the problem (see Terninko, Zusman & Zlotin, 1998). Based on the rules of using the problem formulator, a set of events was extracted. The events were linked to each other as shown in Figure 1.

A total of 11 problem statements were formulated (see Table 2). With analysis of the abstract problem statements, a number of possible solutions can be interpreted within the context of canteen operations.

In addition to the use of the problem formulator, the problems found in this case study could also be analysed with the use of contradiction analysis. It is not difficult to identify the two conflicting aspects in the original system, which are the operating hours of the food outlets and customer demand. Thus the contradiction can be structured as 'the operation time should be long enough in order to meet the dining needs of students and staff'. However, operation time should not be too long, because it is not cost-effective for the food-outlet operators. The essence of eliminating this contradiction is to take effective measures to either stretch the operation time or to condense/concentrate the demand of the customers into a shorter time period. Based on extreme situation analysis and combined with the 4 separation principles and 40 inventive principles, a number of solutions are proposed to eliminate the contradiction. They include:

1. *Separation in space.* Separate food preparation from food supply by contracting food preparation to off-campus operators and using phone ordering, direct delivery or other means to supply food in batches to campus.
2. *Separation within a whole and its parts, and segmentation.* Segment the dinning needs of customers into different types and patterns. Categorize those who have particular needs such as late dining, and provide a special service for them.
3. *Separation in time.* Divide the operation hours of the food outlets into two parts (i.e. daytime operation and night-time operation) so that different operators can use the existing outlets for night-time operation.
4. *Self-service.* Using a deliver-on-order service, customers can collect the ordered food by themselves at designated collection points. Office pantries can be provided such

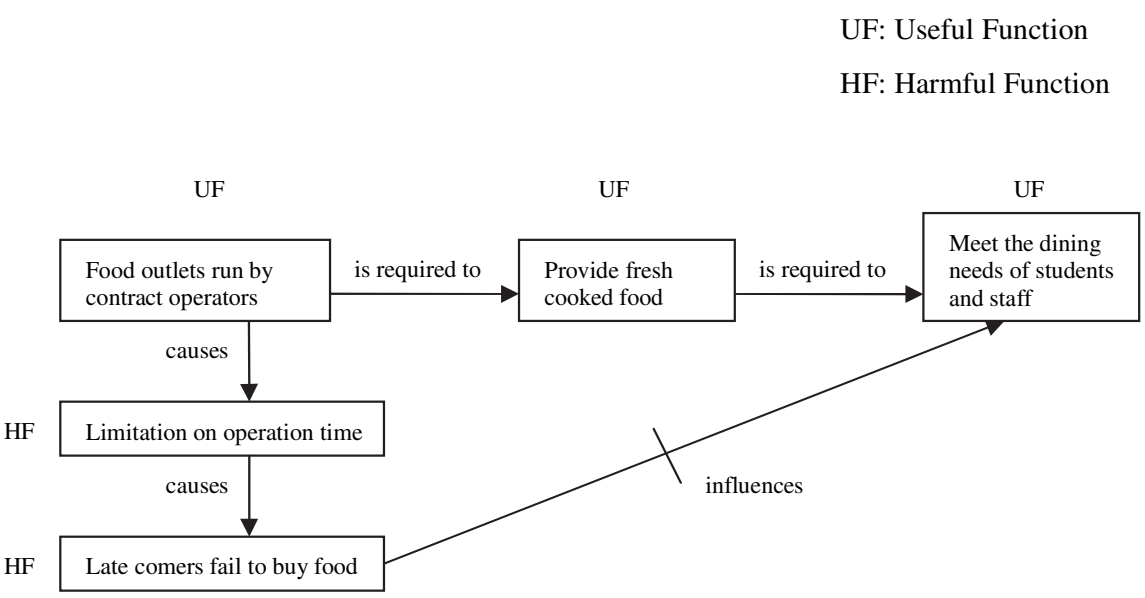

Figure 1. Functional Diagram of the Problem of Food Outlet Operation

Table 2. Interpretation of the Formulated Problem Statements

Problem Statement	Practical Indication
1) Find an alternative way to obtain the useful function of [Meet the dining needs of students and staff] that does not require [Fresh cooked food] and is not influenced by [Later comers fail to buy food].	Find alternative ways of delivering food or replacements of fresh cooked food so that people can come and buy at anytime. Examples: Direct sale of ordered food, automated vending machine, canned food, provide office pantry so that students can cook or heat own food, etc.
2) Find a way to enhance the effectiveness of [Meet the dining needs of students and staff].	
3) Find an alternative way to obtain the useful function of [Fresh cooked food] that can provide [Meet the dining needs of students and staff] and does not require [Food outlets run by contracted operators].	Find alternative ways to obtain fresh cooked food without relying on contracted operator. Example: Contract with off-campus operators who can operate without time constraint.
4) Find a way to enhance the effectiveness of [Fresh cooked food].	
5) Find an alternative way to obtain the useful function of [Food outlets run by contracted operators] that provides [Fresh cooked food] and does not cause [Limitation on operation time].	Find alternative ways to operate existing food outlets without time constraint. Example: Encourage a few existing operators to extend operation time.
6) Find a way to enhance the effectiveness of [Food outlets run by contracted operators].	
7) Find a way to resolve the contradiction that [Food outlets run by contracted operators] should be established in order to provide [Fresh cooked food], but it should not be established in order to avoid causing [Limitation on operation time].	
8) Find a way to eliminate, reduce, or prevent the harmful function of [Limitation on operation time] in order to avoid causing [Later comers fail to buy food] under the condition of [Food outlets run by contracted operators].	Find alternative ways to serve customers without time constraint. Example: New packaging way to sustain the freshness of food so that operators can first cook food on order, and then deliver to designated places where customer can collect the food.
9) Find a way to benefit from [Limitation on operation time].	
10) Find a way to eliminate, reduce, or prevent the harmful function of [Later comers fail to buy food] in order to avoid influencing [Meet the dining needs of students and staffs] under the condition of [Limitation on operation time].	
11) Find a way to benefit from [Later comers fail to buy food].	Find some means to change the customer demand cycle. Example: Early bird discount.

that late diners can self-resolve the problem by cooking or heating their own food.
5. *Preliminary action.* Set up complementary measures, such as providing food-vending machines and/or pantries to relieve peak-hour demand and also meet the needs of late comers.

As demonstrated in the process of problem solving, a number of possible solutions were generated to address the canteen operation hours problem through using TRIZ tools. With the evaluation from a customer workshop, solutions such as outsourcing food supply or setting up new outlets for night operation were considered feasible for implementation. The implementation of these ideas required the support of the university. Another solution is to launch a new food-ordering service on campus. Students and staff can order their food via the telephone or Internet. The food can be prepared using contracted operators, who can be either from the existing canteens or from off-campus restaurants. The ordered food can be delivered to designated collection points, or delivered directly to offices. A service fee would be charged.

Discussion and Implications

With a powerful knowledge base as its foundation, TRIZ contrasts with other problem-solving methodologies through its unique way of delivering quality and innovative solutions without compromise. The effectiveness and efficiency of using TRIZ in technical problem solving have been proven through over four decades of practice. Non-technical problem solving, as a new area in which to apply TRIZ methodologies, is receiving increasing attention. Service product design is a promising avenue with much potential to benefit from their integration with TRIZ. Taking this as an objective, this research project applied modification of selected TRIZ tools, such as the problem formulator and the 40 inventive principles, to resolve problems in service operations. Its successful application in this study confirms the premise that the TRIZ knowledge base is applicable to a wide scope of problem-solving situations.

The success of using TRIZ in service operations also contributes to the literature on NSD. Unlike existing service design tools, a TRIZ-integrated service conceptual approach can help service developers to overcome their psychological inertia and generate many quality and potentially breakthrough ideas throughout the process of service conceptualization. In the present case study of restructuring canteen operations, the use of TRIZ tools redefined the problem situation, revealed the inherent contradiction and generated multiple quality solutions in a systematic manner. Moreover, during the problem-solving process, ideas were generated throughout the entire conceptual design process. Such a process allows service designers to stop as soon as satisfactory solutions are found, thus saving time and cost.

The implementation of this new method in NSD may be beneficial to service companies in several ways. First, as a formalized approach, this method at least fills in a void of previously unsystematic practices of some companies in developing new services. Second, it has the potential to shorten development cycle time which may in turn lead to cost savings and an overall shorter time-to-market. Third, having a powerful knowledge base that consists of a collection of innovative patterns, TRIZ can help practitioners to develop new services in the first place by avoiding the need to 'reinvent 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 proposed a new method of service conceptual design based on the TRIZ methodology. We argue that with appropriate modification, TRIZ tools can be applied to service problem solving. An empirical case example validated the use of TRIZ tools such as the problem formulator, contradiction analysis and the 40 inventive principles, in resolving problems in service operations. Although at this stage the classical knowledge base of TRIZ may not be able to reflect all the distinct innovation patterns found in services, we believe that the effectiveness of using TRIZ in the service domain can be further enhanced through the incorporation of best practices knowledge. The implementation of this approach should be able to address the existing gaps in service development, and have a significant impact on the industrial practice of new service development.

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