40 Inventive Principles with Applications in Service Operations Management

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1. INTRODUCTION

In the recent development of TRIZ research, much effort has been put in extending TRIZ to a broader application, especially the application in non-technical areas. So far several TRIZ tools have been found to be equally effective in addressing non-technical problems. A good example is that 40 Inventive Principles has recently found its applications in quite a few areas, such as business (Mann, et al., 1999), quality management (Retseptor, 2003), etc. This obviously signals the viability of using TRIZ in more areas, and the promising future of TRIZ development.

To be in line with the effort of extending TRIZ applications, and the progressing project of implementing TRIZ in service sector (Zhang, et al., 2003), in this article we interpret 40 Inventive Principles, which is considered to be one of the most accessible and useful TRIZ tools, with the examples in service operations management. Service development is differentiated from physical product development because of the unique characteristics of service products, such as customer participation, simultaneity, heterogeneity, intangibility and perishability, etc. This determines that the resolution of problems in service operations requires a tighter coupling between marketing and operations aspects.

The included service examples are used for the purpose of illuminating the possible meanings of the 40 inventive principles in service sectors. However, this version of 40 inventive principles is not intended for a complete set of innovation patterns in service industries. On the contrary, through the collection of service examples, we find not all of the 40 inventive principles are distinct for service industries. For instance, Principle of Homogeneity is much less used in service sector than its reverse, heterogeneity. This is because the combination of intangibility and customer participation in service delivery system usually results in variation of service from customer to customer (Fitzsimmons, et al., 2001). Therefore, to better apply 40 inventive principles to service sector, a more tailored version of the principles might have to be created. One of the ways to do it is to examine and benchmark across different service industries the best practices or service innovations, which imply the application of TRIZ inventive principles. This might be helpful to better portrait the generic TRIZ innovation patterns in service sectors.

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2. 40 INVENTIVE PRINCIPLES

Principle 1. Segmentation

A. Divide an object or system into independent parts.
   - *Service packages can be divided into several components: supporting facility, facilitating goods, explicit services and implicit services [2].*

B. Make an object or system easy to disassemble.
   - *The body of customers can be segmented based on the information such as their needs, ages and buying behaviors, etc. (e.g., United Services Automobile Association targets its business of automobile insurance only on military officers, a group that presents lower-than-average risk of problems requiring compensation [2]; wholesale companies can target customers who are willing to buy in quantity, do without frills, and serve themselves).*

C. Increase the degree of fragmentation or segmentation.
   - *Service centre can improve service delivery efficiency by segmenting the service ranges into several categories, and pre-arranging them in the tape of automatic phone answer system. It shortens the time for customers to find the right consultant for enquiry.*

Principle 2. Taking out

A. Separate an interfering part or property from an object or system, or single out the only necessary part (or property) of an object or system.
   - *Automated Teller Machines extract the core functions which essentially perform the banking transactions such as cash withdrawal and funds transfer, and make them happen outside banks.*
   - *Online reservation system(e.g., airline, hotel, and cinema)*
   - *Hospitals send out blood donation ambulances so that donators do not have to travel to the hospitals*

Principle 3. Local quality

A. Change an object's or system's structure from uniform to non-uniform; change an external environment (or external influence) from uniform to non-uniform.
   - *Service offerings should be customized based on the needs of customers (e.g., public buildings must provide various entrances for people who can drive in, walk in, or even for those who are handicapped to entry.)*

B. Make each part of an object or system function in conditions most suitable for its operation.
   - *The layout design in large grocery stores, like Safeway, and superstores, like Wal-mart, emphasizes strategic product placement and customer flows through their stores to maximize sales and convenience [4].*
   - *Restaurants usually choose their locations at heavily populated areas to maximize the revenues.*

C. Make each part of an object or system fulfill a different and useful function.
    - *Different from service staff, customer as one of the unique elements in service delivery can play a vital role to improve the quality of service offerings (e.g., patient's accurate descriptions of their symptoms will help doctors to provide effective prescriptions; in fast food restaurants, customers assemble their own dishes which cater to their taste)*
    - *In most service industries, service package is be a mix of tangible and intangible goods, which play their own functions respectively for creating good experience for customers (e.g., the atmosphere of a restaurant and the cheerfulness of its waiters might be as important as the taste of the food it sells).*

Principle 4. Asymmetry

A. A. Change the shape of an object or system from symmetrical to asymmetrical.
    - *Sometimes, providing customized service offerings instead of standard ones would help to create a unique experience to customers (e.g., customers are greeted with their names in hotel reception counters; hair salons make records of customer preferences).*

B. If an object or system is asymmetrical, increase its degree of asymmetry.
    - *Customer differentiation (e.g., Banks offer free financial consulting services for clients who deposit high savings).*

Principle 5. Merging

A. Bring closer together (or merge) identical or similar objects or systems; assemble identical or similar parts to perform parallel operations.
    - *In shopping malls, cashier counters are usually positioned together to expedite the transaction time.*
    - *Identical products or similar products are usually put together for the convenience of customer (e.g., similar goods in supermarket; works of the same times, or the same artist, or the same topic, are displayed together in museums).*
    - *Collaboration and partnerships among service organizations (e.g., theaters invite famous bands, singers for shows).*

B. Make operations contiguous or parallel; bring them together in time.
    - *Bundling services and operating them together (e.g., an admission to Disney world means visitors can enjoy a variety of attractions, fantastic atmosphere which can help to create wonderful experiences in the mind of customers.).*

Principle 6. Universality

A. Make a part or object or system perform multiple functions; eliminate the need for other parts.
    - *A service offering might perform multiple functions by satisfying various needs of customers (e.g., by purchasing a meal, customer can enjoy a package of service offerings which might include a set of delicious food, a cozy environment with light music, nice interaction with servers and some other intangible elements. Each of these elements plays its own function and they altogether provide a nice experience in the minds of diners).*
B. Use standardized features
    - *Performance consistent service delivery (e.g., McDonald's, French fry food).*
    - *ISO 9004-2:1991(E) - Guide to Quality Management and Quality Systems Elements for Services*
    - *Scoring system used for customer selection and solicitation*

Principle 7. "Nested doll"

A. Place one object or system inside another; place each object or system, in turn, inside the other.
    - *Flight traveling would be a boring experience if no more extra services like entertainment are incorporated in the flight package.*
B. Make one part pass through a cavity in the other.
    - *The operations of back office should not be isolated from the operations of front office (e.g., Receptionists should know the operational status in hotel rooms, such as occupancy and cleaning status).*

Principle 8. Anti-weight

A. To compensate for the weight of an object or system, merge it with other objects or systems that provide lift.
    - *Organizations invite consulting firms to help to identify and solve problems*
    - *Theaters invite famous bands, singers to provide interesting shows, concerts in order to attract audiences*
    - *To attract more customers to accept and use internet banking services, and to save tremendous expense from marketing, e-banks often collaborate with the large traditional banks to gain recognition rapidly from customers*
B. To compensate for the weight of an object or system, make it interact with the environment (e.g. use aerodynamic, hydrodynamic, buoyancy and other forces).
    - *Customers can become a communication medium of service firms who offer high quality services (e.g., word-of-mouth effect).*

Principle 9. Preliminary anti-action

A. If it will be necessary to do an action with both harmful and useful effects, this action should be replaced with anti-actions to control harmful effects.
    - *Before the commercialization of a new service product, preventive analysis should be done to identify any potential failure points in the service offering.*
B. Create beforehand stresses in an object or system that will oppose known undesirable working stresses later on.
    - *"Help" file is always included in software to help users to solve problems whenever they meet*
    - *Software or hardware providers offer free technology support for customers through online enquiry, or telephones*

Principle 10. Preliminary action

A. Perform, before it is needed, the required change of an object or system (either fully or partially).
    - *Customer-contact personnel are representatives of service firms. So basic training for the skills like customer interaction skills is needed before they begin to work and represent for companies.*
    - *Nice setting for service facilities would be beneficial to create wonderful experiences for customers (e.g., coffee shops, theaters).*
    - *Put up sign posters and location maps as route directions for visitors.*
B. Pre-arrange objects or systems such that they can come into action from the most convenient place and without losing time for their delivery.
    - *The "hub-and-spoke" network delivery concept used by Federal Express*
    - *Customers are allowed to rent cars from one of the chain shops and then return it later to any one of the chain shops closest to them*
    - *Strategic placement of commodities in shopping malls [4]*
    - *To shorten the check out time, many hotels total the bills and slide them under the guest room doors during the last night of their stays, thereby achieving "zero waiting time".*

Principle 11. Beforehand cushioning

A. Prepare emergency means beforehand to compensate for the relatively low reliability of an object or system.
    - *To manage service capacity and smooth customer demand, service firms can use a set of preventive strategies such as price differentials to encourage off-peak demand, advertising early to avoid seasoning rush, and using appointment and reservations.*

Principle 12. Equipotentiality

A. In a potential field, limit position changes (e.g. change operating conditions to eliminate the need to raise or lower objects or systems in a gravity field).
    - *Car renting companies usually have a scatter of branch shops. Customers can rent car at any shop, drive it around and then return it later to any one of the chain shops closest to them (it is also shown in Principle 10, preliminary action)*
    - *The emergence of e-banking transforms the traditional transactions into online transactions which makes the distance between banks and customers just a few clicks away.*

Principle 13. The other way round

A. Invert the action(s) used to solve the problem (e.g. instead of cooling an object or system, heat it).
    - *With the advancement of e-services, customers do not have to go shopping at physical stores as before. They can shop and make payment online by just sitting at home and wait for the delivery of purchased products to their homes.*
B. Make movable parts (or the external environment) fixed, and fixed parts movable).
    - *Service companies can earn competitive advantages by delivering on-site services (e.g., ASUS provides on-site warranty services in the first year of the purchase of its laptops).*
    - *Emergency ambulances travel to the places of patients*
C. Turn the object (or process) 'upside down'.
    - *On many occasions, customers can self-service them instead of waiting helps from service staff (e.g., websites often put answers to FAQs; students can always learn by themselves)*

Principle 14. Spheroidality

A. Instead of using rectilinear parts, surfaces, or forms, use curvilinear ones; move from flat surfaces to spherical ones; from parts shaped as a cube (parallelepiped) to ball-shaped structures.
B. Use rollers, balls, spirals, domes.
C. Go from linear to rotary motion, use centrifugal forces.
    - *The process of new service development is highly iterative rather than just being linear.*
    - *Feedbacks from customers and frontline staff (marketing and sales) are valuable to developing new services.*

Principle 15. Dynamics

A. Allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition.
    - *Service firms can empower frontline staff the discretionary right in delivering services. (e.g., Joie de Vivre Hotel Chain has a dream-maker program. Their employee can create a customized welcome gift for VIP customers).*
B. Divide an object or system into parts capable of movement relative to each other.
    - *The team of new service development should consist of the members from cross-functional departments*
C. If an object (or process) is rigid or inflexible, make it movable or adaptive.
    - *Customer demands usually follow certain pattern. Thus service firms can try to adapt service capacities to meet customer demands (e.g., airlines increase flights during peak season; restaurants hire temporary staff).*

Principle 16. Partial or excessive actions

A. If 100 percent of an object or system is hard to achieve using a given solution method then, by using 'slightly less' or 'slightly more' of the same method, the problem may be considerably easier to solve.
    - *Giving beforehand notices and explanations to customers for temporary unavailability of services can prevent loss of customer loyalty due to blind waiting (e.g., websites put notice links, for instance, server upgrading, to explain the temporary failure of services; window service staff put notice like "20 minutes back" or "service starts from 2pm" to avoid blind waiting for customers)*
    - *Customers can be delighted if the perceived service quality exceeds their expectations (e.g., conference or meeting organizers send reminder letters or emails to attendants before the meeting and also send follow-up letters to thank their presence after the meeting; many mall centers provide kid caring services and amusement so that parents can do shopping with ease).*

Principle 17. Another dimension

A. To move an object or system in two- or three-dimensional space.
    - *Multi-dimensional customer satisfactions surveys; the use of House of Quality in service design [5].*
    - *Multi-level sales system (e.g., Amway or Avon sales system).*
B. Use a multi-story arrangement of objects or systems instead of a single-story arrangement.
    - *The organization structure of McDonald's is pyramid-shaped, with layers of supervision from the assistant store manager, store manager, and regional manager to corporate "consultants", to ensure consistency of service delivery across all locations [2].*

- *Differentiate and segment customers on the basis of their needs, behaviors, ages, etc.*

C. Tilt or re-orient the object or system, lay it on its side.
D. Use 'another side' of a given area.

Principle 18. Mechanical vibration

A. Cause an object or system to oscillate or vibrate.
   - *Benchmarking the best practices across different service industries would be helpful to improve the service quality, and keep innovating in developing service offerings.*
   - *Varying the required service capacity with the fluctuation pattern of customer demands (e.g., fast food restaurants hire temporary staff to service customers on peak times)*

B. Increase its frequency (even up to the ultrasonic).
   - *Ritz Carlton Hotels have 10 minutes per day of employee training, instead of long classes at less frequent intervals.*

C. Use an object's or system's resonant frequency.
   - *Consulting firms need to work "in harmony" with their clients with the goal of resolving problems*
   - *The use of Just-In-Time (JIT) inventory systems in supply chain management*

D. Use piezoelectric vibrators instead of mechanical ones.
E. Use combined ultrasonic and electromagnetic field oscillations.

Principle 19. Periodic action

A. Instead of continuous action, use periodic or pulsating actions.
   - *To many service industries, it is not cost-effective, or no point at all, to keep service capacity fixed throughout the time (e.g., Airlines increase flights on hot routing in tour season; cinemas put on more show sessions in weekends)*

B. If an action is already periodic, change the periodic magnitude or frequency.
   - *Consumer demands in some service industries typically exhibits very cyclic behavior over periods of time, with considerable variation between the peaks and valleys. Some means might be helpful to smooth the magnitude of demand on the peak time (e.g., some rail lines charge less for off-peak trains; restaurants offer early-bird discounts).*

C. Use pauses between impulses to perform a different action.
   - *In the operations of back office, inspections of the working conditions of machines should be regular (periodic) to prevent the accidental break-down.*
   - *Employee can be trained during periods of low customer demand, and thus be prepared for periods of high demand.*

Principle 20. Continuity of useful action

A. Carry on work continuously; make all parts of an object or system work at full load, all the time.
    - *Some service organizations develop a retirement job bank of their retired employees that is used a source of skilled labor to fill in during peak work times, absences, and vacations [2].*
    - *Some services and facilities are in the state of continuous delivery (e.g., radio programs, customer hotlines, public highway).*
B. Eliminate all idle or intermittent actions or work.

Principle 21. Skipping

A. Conduct a process, or certain stages (e.g. destructible, harmful or hazardous operations) at high speed.
    - *The procedure for X-ray mammograms is uncomfortable for the patient. The actual X-ray exposure only takes a few seconds, but the positioning the patient can take several minutes. If technicians learn how to operate the positioning quickly, and how to release the pressure on the instant the X-ray is taken, patients are more likely to return.*
    - *Keep customers in waiting for long takes the risk of losing their loyalty. Shortening the waiting time (Skipping this harmful time) can be realized by setting up more service counters, or hire more part-time employees during peak times.*
    - *An alternative way to manage waiting line is to let customers feel that the waiting time was skipped psychologically (e.g., Disney employs entertainment for people waiting in line; high-rise buildings put mirrors on elevator doors to make people less maniacal during waits).*
    - *To increase the automation level, many service organizations try to shorten the direct customer contact time (e.g., the use of automated phone answering systems or online reservation system)*
    - *The "zero waiting time" achieved by hotels (Also shown in the Principle of Preliminary Action)*

Principle 22. "Blessing in disguise" or "Turn Lemons into Lemonade"

A. Use harmful factors (particularly, harmful effects of the environment or surroundings) to achieve a positive effect.
    - *Service firms can improve the quality in service delivery by listening to customer complaints.*
    - *If a service failure occurs or a potential service fail point is identified, service companies can respond fast and take effective measures to fix the problem. It can create very positive perceptions about service quality in the minds of customers (e.g., Microsoft publishes patches in time to software products to improve their quality; serving complimentary drinks on a delayed flight can turn a potentially poor customer experience into*

good one; the credit of Singapore was upgraded because of the success of its effort in containing SARS [1]).

B. Eliminate the primary harmful action by adding it to another harmful action to resolve the problem.

   Amplify a harmful factor to such a degree that it is no longer harmful.

   - *In professional services (e.g., consulting), price for purchasing service offerings is often considered a surrogate for service quality. Thus high pricing of this kind of service products with excellent quality may be a competitive strategy.*

Principle 23. Feedback

A. Introduce feedback (referring back, cross-checking) to improve a process or action.
   - *Instant feedback on sales and inventory movements can be obtained through the use of RFID (radio frequency identification) tags. This can result in a better match of inventory to customer needs.*
   - *Use of patients' medical record and listening to their feedbacks to previous prescriptions can greatly influence the effectiveness of the attending physician [2].*

B. If feedback is already used, change its magnitude or influence.
   - *Increase the collection of feedback data from customers and frontline staff by using the means such as focus group, brainstorming, lead user interview, etc.*
   - *Instead of waiting for customer feedback, some companies proactively use computerized information system (e.g., bar coding or checkout scanner technology) to collect and analyze customer buying behaviors.*

Principle 24. 'Intermediary'

A. Use an intermediary carrier article or intermediary process.
   - *A large number of service firms are intermediaries (e.g., job agents, travel agents, law firms, etc.)*
   - *Customer-contact personnel are representatives of service firms, or the intermediaries between service firms and customers. Their performances affect the image of service firms directly.*
   - *Some physical goods play the roles as intermediary in creating customer experiences for delivered services (e.g., purchased food in restaurant; replacement parts for servicing).*
   - *Customers can be advertisers of service offerings (e.g., a happy customer is willing to share with his friends the experience of a good service).*

B. Merge one object temporarily with another (which can be easily removed).
   - *In some industries, customers or "their representatives" must temporarily stay with supporting facilities in the course of service delivery (e.g.,*

customers stay on airplanes during flights; mail letters are in the hands of post offices during forwarding)

Principle 25. Self-service

A. Make an object or system serve itself by performing auxiliary helpful functions
   - *In fast-food restaurants (e.g., cafeteria, salad bar), customers play the roles as partial employee. By doing this, customer can actually assemble the meals for their preferences, and help to augment the work of service staff.*
   - *The effectiveness of education is largely dependent on the students' own effort.*

B. Use waste resources, energy, or substances.
   - *Evaluate situations of bad services to improve (e.g., Hospitals track how often patients are re-admitted with the same problem to measure "waste" of treatment.*

Principle 26. Copying

A. Instead of an unavailable, expensive, fragile object or system, use simpler and inexpensive copies.
   - *In many museums, visitors have a cheaper option to hiring a tour guide, that is, to rent an audio guide*

B. Replace an object or system, or process with optical copies.
   - *Microfilms are used to store huge volumes of books.*
   - *Use of a projector and transparency copies in lecturing.*

C. If visible optical copies are already used, move to infrared or ultraviolet copies.

D. Copy creative service concepts across different industries.
   - *The EZ-link card and general ticketing machines employed in Singapore MRT (city train) and bus systems are similar in concept to bank credit card and automated teller machines.*
   - *Southwest Airlines cut its turnaround time by 50% through observing how the pit crews of Indianapolis 500 fuel and service race cars.*
   - *Gas utility company can speed the delivery of its own product by examining how Federal Express delivers packages overnight [2].*

Principle 27. Cheap short-living objects

A. Replace an inexpensive object or system with multiple inexpensive objects or systems, compromising certain qualities (such as service life, for instance).
   - *During SARS period, canteen food outlets in Singapore use disposable cutlery to substitute recyclable ones in order to contain the disease [1]*
   - *Many software companies allow potential customers to download and use their products for a trail period or limited times of free usage. This helps customers to experience the functions of products before they make decision to buy formal ones.*

- *Movie trailers are usually released quite early before the show of movies.*

Principle 28 Mechanics substitution

A. Replace a mechanical means with a sensory (optical, acoustic, taste or smell) means.
   - *Video tape of lectures and CD recordings of concerts represent convenient substitutes for physical attendance*

B. Use electric, magnetic and electromagnetic fields to interact with the object or system.
   - *Applying manufacturing technologies to automate the back-office operations in service companies (e.g., airport luggage-handling system)*
   - *In traditional service delivery, customers must travel to service facilities, or servers must travel to places of customers. Electronic communication can be substituted for physical travel (e.g., learning knowledge through registering online class; conducting video conference).*

C. Change from static to movable fields, from unstructured fields to those having structure.
   - *Internet technologies enable the real-time communication with visual images, which is a revolutionary change from the traditional way of calling over phone*

D. Use fields in conjunction with field-activated (e.g. ferromagnetic) particles.

Principle 29. Pneumatics and hydraulics (Intangibility)

A. Use intangible parts of an object or system instead of tangible parts
   - *The brand images of service organizations can be a guarantee for service quality (e.g., social recognition for academic degrees from top universities, which may stand for high quality of education for degree holders)*

Principle 30. Flexible shells and thin films

A. Use flexible shells and thin films instead of three dimensional structures

B. Isolate the object or system from the external environment using flexible shells and thin films.
   - *Some trains use automated shutting doors to isolate smoking compartments away from non-smoking compartments.*

Principle 31. Porous materials

A. Make an object or system porous or add porous elements (inserts, coatings, etc.).
   - *Some supermarkets open a green cashier counter in peak time for customers who just buy a few items so that they can check out quickly and do not have to wait in the long queue.*
   - *There should be a channel for service providers to listen to the voice of customers. Information technologies create the opportunity for service*

providers to interact more frequently with customers (e.g., after some companies implemented live chat function on their websites to expedite the interactions with customers, their sales closures rise dramatically).

B. If an object or system is already porous, use the pores to introduce a useful substance or function.
    - *In order to develop better products or enhance service quality, service providers can encourage and reward customers to feedback their experiences of consuming delivered service products (e.g., use customer focus group to assess new services before formal launches, or involve customers participation in new idea generation)*

Principle 32. Color changes

A. Change the color of an object or system or its external environment.
    - *Changing the color of a service facility might be able to influence the customer's perception of the service (e.g., renovate restaurants with warm color in winter).*
    - *Avoiding any typical hospital color "association" might be helpful for rapid recovery for patients.*

B. Change the transparency of an object or system or its external environment.
    - *Sometimes it is useful to promote customer confidence by making part of service operations transparent to public scrutiny (e.g., some restaurants provide a view into the kitchen; some auto repair shops can be observed through windows in the waiting area; some hair salons can be viewed from outside) [2].*

Principle 33. Homogeneity

A. Make objects or systems interacting with a given object or system of the same material (or material with identical properties).
    - *Some hospitals encourage the patients who have received surgery to discuss their experiences with new patients to alleviate their preoperative fears; Schools encourage students to help each other to clarify puzzles during study.*

Principle 34. Discarding and recovering

A. Make portions of an object or system that have fulfilled their functions go away (discard by dissolving, evaporating, etc.) or modify these directly during operation.
    - *Some of the elements in service packages will be consumed after they fulfill the assistance job to create the experiences in the minds of customers (e.g., food/drinks offered by restaurants; medicines provided by hospitals; knowledge taught by teachers).*

B. Conversely, restore consumable parts of an object or system directly in operation.

Principle 35. Parameter changes

A. A. Change an object's or system's physical state (e.g. to a gas, liquid, or solid.)
    - *The emergence of information technologies turns brick-and-mortar banks into intangible e-banks.*
B. Change the concentration or consistency.
    - *The "focus" service strategy rests on the premise that service firm can serve its narrow target market more effectively and/or efficiently than other firms trying to serve a broad market [2].*
C. Change the degree of flexibility.
    - *Sometimes, adding customization to a standard service offering may endear a firm to its customers at very little cost. Examples: A hotel operator who is able to address a guest by name can make an impression that translates into repeat business; Hair salons have added many personalizing features (e.g., personal stylist, juice bar, relaxed surroundings, mood music) to differentiate themselves from hair shops; Burger King's efforts to promote a made-to-order policy is an attempt to differentiate itself from McDonald's classic make-to-stock approach to fast-food service.*
    - *Museums send their top art works for stroll exhibitions over the world; famous circuses make travel shows across many places*
D. Change the atmosphere to an optimal setting.
    - *A coffee bar might need a relaxed environment with mood music as background.*
    - *A nightclub might need some special recreation programs to match the moods of customers.*

Principle 36. Phase transitions

A. Use phenomena occurring during phase transitions (e.g. volume changes, loss or absorption of heat, etc.).
    - *Recreation centers launch different new leisure programs in different seasons.*
    - *With the aging of the club members, some resort clubs might design more family activities to cater to the evolution of these members' needs.*

Principle 37. Thermal expansion (Strategic expansion)

A. Use thermal expansion (or contraction) of materials.
    - *Some service industries use adaptable service capacity to cater to fluctuating demands of customers (e.g., restaurants hire temporary staff to meet peak demands; airlines increase flight amounts during tour season).*
    - *Popular restaurant is hot so that it can expand to world-wide chain (e.g., Hard Rock Café, KFC, Wolfgang Puck, etc.)*
B. If thermal expansion is being used, use multiple materials with different coefficients of thermal expansion.

Principle 38. Strong oxidants (Boosted interactions)

A. Replace common air with oxygen-enriched air (more exposure to customers)
    - *Contrary to the closed-system perspective that is taken in manufacturing, service operations adopt an open-system concept because of the presence of customers in the process of service delivery [2]. This helps to enrich company's knowledge of its customers.*
B. Replace enriched air with pure oxygen (increase the level of customer participation in service delivery)
    - *Further enhance the role of customers as co-producers in service delivery (e.g., the evolution of customer roles in service delivery from traditional banking, to phone banking, to internet banking).*
C. Expose air or oxygen to ionizing radiation.
D. Use ionized oxygen.
E. Replace ozonized (or ionized) oxygen with ozone.

Principle 39. Inert atmosphere

A. Replace a normal environment with an inert one.
    - *During the period of SARS outbreak, patients who are infected the disease must be quarantined in order to prevent further spreading.*
    - *Use of neutral third parties during difficult negotiations [3]*
B. Add neutral parts, or inert additives to an object or system.
    - *Break time for a lecture.*

Principle 40. Composite materials

A. Change from uniform to composite (multiple) materials.
    - *Adding tangible elements into service offerings can give customers physical reminders of their purchases of the intangible services (e.g., airlines send souvenirs to passengers; hotels provide complimentary toiletry items with the hotel name prominently affixed).*
    - *Use multi-media in education-lecture with music and video.*

3. CONCLUSION

This article interprets the possible meanings of the classic 40 inventive principles with examples from service operations. Despite the differences between goods industries and service industries, it is found that most of inventive principles and their innovation patterns can be well-applied to service sector. To make the process of applying these principles systematic and enable greater impacts on service development practices, a service-specific contradiction matrix might be desirable to be created. One recommendation to accomplish this goal is to link generic service design attributes (e.g., the 13 service design factors listed in Metters et al., 2003) together with 40 inventive principles through categorized examples of service innovations.

4. REFERENCES

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[6] Zhang, J., Tan, K.C., and Chai, K.H. (2003), "Systematic innovation in service design through TRIZ", The TRIZ Journal, September Issue, pp. 1-12, http://www.triz-journal.com/archives/2003/09/index.htm

This month's (December 2003) TRIZ Journal article, "40 Inventive Principles with Applications in Service Operations Management", is another attempt to be in line with the effort of extending TRIZ applications and to (mis)interpret 40 Inventive Principles, which is considered to be one of the most accessible and useful TRIZ tools (accessible and useful for misinterpretations - certainly!). The authors of the article correctly conclude that their effort was not entirely successful, but they incorrectly blame this on some specifics of their subject matter rather than on their own lack of imaginat...Â Why to waste time on insignificant areas, such as business, quality management, etc.? Let's go straight to the source of all sources, creation of all creations: the Book of Genesis. Operations management was previously called production management, clearly showing its origins in manufacturing. Historically, it all began with the division of production, starting as early as the times of ancient craftsmen, but spreading more widely only by adding the concept of interchangeability of parts in the eighteenth century, ultimately sparking the industrial revolution.Â The service side also began its approach by applying product management principles to the planning and organizing of processes, to the point where it made more sense to call it operations management. Multidisciplinary nature. Operations management is now a multidisciplinary functional area in a company, along with finance and marketing. @inproceedings{Article200840I, title={40 Inventive (Business) Principles With Examples}, author={September Article and D. Mann and E. Domb}, year={2008} }. September Article, D. Mann, E. Domb. Published 2008. Engineering. Interest in the possible applicability of TRIZ tools and techniques to the world of management and organisational innovation issues continues to grow. The aim of this article is to place the 40 Inventive Principles of TRIZ in the context of this business environment. The format of the article is based closely on an earlier text (1) in which examples of technical deployment of Management: Principles and Practices for Sustainable Operations and Management David B. Grant|Che Operations Research and Management Science Handbook (The Operations Research Series). 904 PagesÂ·2008Â·236 KBÂ·14,361 DownloadsÂ·New! analysis of problems from which managers can make objective decisions. Operations Research and Managem Production and Operations Management : With Skill Development.Â Operations Management in Automotive Industries: From Industrial Strategies to Production Resources Management, Through the Industrialization Process and Supply Chain to Pursue Value Creation. 258 PagesÂ·2014Â·4.77 MBÂ·7,403 DownloadsÂ·New! in the world of automotive engineering and the automotive industry in general.

40 Inventive Principles for resolving technical contradictions. Genrich Altshuller discovered forty patterns of inventive solutions, known as 40 Inventive Principles. (TRIZ â€“ Theory of Inventive Problem Solving).Â Different formats for the 40 Inventive Principles were developed: 1. 40 Inventive Principles by G.S. Altshuller 2. 40 Inventive Principles by Oxford Creativity 3. 40 Inventive Principles by Karen Tate and Ellen Domb. 40 Inventive Principles. In: Genrich Altshuller. The Innovation Algorithm: TRIZ, Systematic Innovation and Technical Creativity.Â a.An object must service itself and carry-out supplementary and repair operations. b.Make use of waste material and energy. 26. Copying. A good example is that 40 Inventive Principles has recently found its applications in quite. a few areas, such as business (Mann, et al., 1999), quality management (Retseptor, 2003), etc. This obviously signals the viability of using TRIZ in more areas, and the promising. future of TRIZ development. To be in line with the effort of extending TRIZ applications, and the progressing project. of implementing TRIZ in service sector (Zhang, et al., 2003), in this article we interpret. 40 Inventive Principles, which is considered to be one of the most accessible and useful. TRIZ tools, with the examples in service operations management. Service development is. differentiated from physical product development because of the unique characteristics of. Retsptor, G. 40 Inventive Principles in Quality Management. Triz J. 2003. Available online: https://triz-journal.com/40-inventive-principles-quality-management/ (accessed on 12 February 2021). Retsptor, G. 40 Inventive Principles in Marketing, Sales and Advertising. Triz J. 2005.Â Zhang, J.; Chai, K.; Tan, K. 40 Inventive Principles with Applications in Service Operations Management. Triz J. 2003. Available online: https://triz-journal.com/40-inventive-principles-applications-service-operations-management/ (accessed on 12 February 2021). Ilevbare, I.M.; Probert, D.; Phaal, R. A review of TRIZ, and its benefits and challenges in practice. Technovation 2013, 22, 30â€“37. Operations management for services has the functional responsibility for producing the services of an organization and providing them directly to its customers.(pp6â€“7) It specifically deals with decisions required by operations managers for simultaneous production and consumption of an intangible product. These decisions concern the process, people, information and the system that produces and delivers the service. It differs from operations management in general, since the processes of service... 40 Inventive Principles. This is the innovative principles for Technical Innovation. For Business Innovation go to https://the-trizjournal.com/40-inventive-business-principles-examples/. Learn and practice the 40 principles with TRIZmeta. Principle 1. Segmentation. Divide an object into independent parts.Â Run the bottleneck operations in a factory continuously, to reach the optimum pace. (From theory of constraints, or takt time operations). Eliminate all idle or intermittent actions or work.Â Principle 25. Self-service. Make an object serve itself by performing auxiliary helpful functions. A soda fountain pump that runs on the pressure of the carbon dioxide that is used to â€œfizzâ€ the drinks.