

# **SARS and 40 Principles For Eliminating Technical Contradictions: Creative Singapore**

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## **Introduction**

The position that the Russian Theory of Inventive Problem Solving (TRIZ) occupies, among other creativity tools, has concerned the western world since the early 1990s. A number of authors over the years provided examples of the application of TRIZ tools in specific areas of technology, covering decades of industrial development [1]. Two papers have been recently published on the application of 40 Principles For Eliminating Technical Contradictions (also known as 40 Inventive Principles, 40 Innovative Principles or simply 40 Principles of TRIZ), highlighting the usefulness of the principles in well-established fields of microelectronics [2] and quality management [3]. These studies are also based on the data covering a considerable period of time (over ten years) and may be contemplated as “the examples of the past”.

Essentially, the 40 Principles of TRIZ is a set of “helpful suggestions” for enlightening engineers and helping them to find sound solutions to their problems. These principles were formulated over a quarter of a century ago and may already be obsolete. In order to judge whether the 40 Principles are still up to date and relevant to the fast changing world of the 21st Century, a modern study is required.

The actions taken by the world against the Severe Acute Respiratory Syndrome (SARS) made such study possible. TRIZ4U associates and friends [4] analysed the measures taken by the authorities of the Republic of Singapore over the last two and a half months (March – May 2003). Singapore was chosen, because of the information on the measures taken by the Republic is available to the general public. Main sources of data used by the authors are *The Strait Times* (Singapore leading newspaper), press releases and official announcements of the Singapore Government, its agencies and Singapore Airlines (SIA). Information from the Singapore official SARS web site was also used.

It has been found that in less than three months:

- Singaporeans showed enormous creativity and innovativeness in their actions
- They “utilised” at least 21 of the 40 original TRIZ Principles
- Most of the Principles were used to resolve non-technical contradictions

The following are the Principles with the examples of its use (the Principles here, are given in a translation of I. Belski. They may be downloaded from [www.triz4u.com](http://www.triz4u.com)).

## **Actions taken in Singapore and the Principles**

### **1. Principle of Segmentation:**

- a. If an object is uniform, make it modular.
- b. Make an object demountable.
- c. If an object is already modular, subdivide it further.

To stop spreading the virus, the Singapore Government identified three groups of people:

- a. those who are already infected or who might be infected,
- b. those who are not infected, and
- c. those entering Singapore who might bring in the virus.

Isolation wards in hospitals have been segmented even further to isolate patients more effectively.

The world is subdivided into the SARS-affected and SARS-free regions with different rules of travel. Preventive measures are set up at all land checkpoints, airports and seaports to monitor anyone with fever.

Critical business operations (e.g. banks, treasuries) are splitting up their teams into different groups and locating them in different office buildings on the island.

The Institutes of Higher Learning are segmenting their large campuses into smaller sections, to reduce movement across the campus and to facilitate contact tracing, should a SARS case occur.

The Pasir Panjang wholesale market, which was quarantined earlier, will be physically reconfigured so that if one area of the market needs to be quarantined, the whole market may not have to.

## **2. Principle of Detachment:**

- a. Detach (remove or separate) the disturbing part or property from an object.
- b. Detach (remove or separate) the essential part or property from an object.

For those who are already infected or who might be infected, the strategy is “detect, isolate and contain”:

- People suspected of being in contact with the SARS patients were asked to stay at home for quarantine.
- All the patients suspected to have SARS were isolated.

## **5. Principle of Combination:**

- a. Combine like objects or objects intended for similar or related operations.
- b. Carry out similar or related operations simultaneously

The cleaners at Changi Airport use chemicals mixed with disinfectants.

## **6. Principle of Universality:**

Design an object to perform multiple functions so that some other objects are no longer needed.

Temperature tests, utilising the infrared sensors, exclude many nurses having to manually measuring temperature at Changi Airport. By mid May there will be 29 infrared detectors at the airport.

## **7. Principle of Nesting:**

- a. Place an object inside another one, which, in turn, is placed inside a third object, etc.
- b. Arrange an object to pass through a hole or a cavity of another object.

Improved isolation by creating a number of enclosed areas from the non-infected to the areas containing SARS-infected patients at Tan Tock Seng Hospital (major SARS facility in Singapore).

**9. Principle of Preliminary Counter-Action:**

- a. If an object experiences a damaging or undesirable stress it has to be prestressed in the direction opposite to the damaging forces.
- b. If the circumstances require carrying out some undesired action, the counter-action must be executed in advance.

From mid April, Singapore authorities closed about 80 markets (small shops and food outlets) for a day of cleaning and disinfecting. They were reopened in a day or two after the clean up.

The taking of medication that strengthens the immune system has been proposed.

The National Environment Agency will pay half the costs of upgrading the toilets, to the owners of food outlets up to a cap of \$5,000.

**10. Principle of Preliminary Execution:**

- a. Accomplish the required action fully or partly in advance.
- b. Prearrange objects to act from the most convenient positions and with no time loss.

From late April, in order to chase up all the possible SARS suspects, every company asks their visitor to fill in a form to keep visitor's contact details (address, passport number, etc).

From the 14<sup>th</sup> of May, SIA passengers receive contact slips on which they can fill in personal details. These can be left at restaurants or shops they visit in Singapore, and will enable them to be contacted if there is an outbreak.

**11. Principle of "Expecting the Worst":**

If an object's reliability is poor have the emergency gear ready in advance.

From late April, web-cameras have been installed in the homes of the quarantined in order to randomly check their presence at home.

Many companies provided every employee with his/her own thermometer.

On the top of checking the temperature of every passenger at Changi Airport, medical personnel are also on hand to offer assistance to those who are visibly ill.

There are empty apartment blocks and chalets set up for occupation, should residents of an entire apartment block be required to be quarantined.

From 12th May 2003 onwards, Singaporeans under Home Quarantine Orders may choose to serve their quarantine at the government chalets at Loyang instead of at home.

"The Government recognises the economic hardship brought about by SARS. To help alleviate the immediate problems, we announced on 17 April a relief package worth \$230 million. These measures were targeted at the sectors most affected by the SARS outbreak, namely, the tourism and transport-related sectors. The measures will not fully offset the impact on these businesses, but they will help them to tide over the difficult period and save jobs, wherever possible".

SIA is giving out health kits to passengers travelling to and from SARS-affected cities (two surgical masks, three antiseptic wipes and one single-use clinical thermometer).

Foreign students will have to think hard before deciding to leave Singapore during the school holidays in June. If they travel anywhere, they will have to re-apply for their student passes before leaving and put up a refundable deposit of \$1,000 each. The \$1,000 deposit is to cover the cost of accommodation or medical screening if the student has to be quarantined on his return.

**15. Principle of Adjustability:**

- a. Make an object (or its environment) automatically adjustable to the changing conditions so as to function optimally through its operational cycle.
- b. Divide an object into parts capable moving and changing relative position.
- c. Convert a stationary object into a mobile one.

SIA continuously adjusts its flights schedule in accordance to the situation with SARS in Singapore and other countries.

**16. Principle of Deficient or Excessive Solution:**

If it is difficult to achieve the desired effect fully, it is required to accomplish “a bit less” or “a bit more” of it. The task may well be significantly simplified.

Every passenger entering and leaving the country is inspected (temperature check and SARS symptoms form).

From 31<sup>st</sup> of March, every passenger looking unwell and arriving to Changi Airport from SARS-affected areas is checked by a nurse. Those who have fever are sent to Tan Tock Seng Hospital (major SARS facility in Singapore) for assessment.

Every person suspected of being in contact with SARS-infected patients is asked to stay under home quarantine (end of March).

Fines of up to \$20,000 and imprisonment were established (end of March) for breaching the quarantine rules.

Ten days “out of work” quarantine for everyone returning from SARS affected areas.

All schools in Singapore were closed from late March to early April.

Businesses are setting up more centres and offices and spreading them around the island instead of combining them into one or two centres, so that if one is required to shut down for quarantine purposes, the rest can still function to keep the economy and business running.

All visits to hospitals were cancelled from early May.

Health officials propose: “It is a useful practice for Singaporeans to take their own temperatures daily, and if they have a fever to stay away from work or school and see their doctor”.

**19. Principle of Periodic Action:**

- a. Replace a continuous action with a periodic (pulsed) one.
- b. If an action is already periodic, change its frequency.

- c. Utilise breaks between pulses to carry out other helpful actions.

Temperature of people involved with the public (schools, taxi drivers, hotel staff and shop keepers, etc.) is measured a few times a day.

SIA flight attendants measure their temperature every 6 hours during flights.

Airport cleaners have doubled the frequency of the cleaning in the terminal buildings.

Streets, markets, drains etc. are cleaned at least twice a day to prevent SARS from spreading in other ways (e.g. through pests, rodents, insects, stray cats or dogs).

Housing estates and common areas like lifts, are cleaned at least three times a day.

## **20. Principle of Continuous Useful Action:**

- a. Carry out operations continuously (all object parts must always operate at full power).
- b. Eliminate idle runs and transitional movements.

Toilets at Changi Airport are now cleaned continuously. A cleaner is in the toilet at all times continuously cleaning all the spills.

A new television channel dedicated entirely to the SARS issue will start on the 20<sup>th</sup> of May, in a first-time partnership between three local media rivals - Media Corporation of Singapore (MediaCorp), StarHub Cable Vision and Singapore Press Holdings (SPH). Apart from the latest updates on SARS, it will air re-runs of programmes about SARS by MediaCorp and SPH MediaWorks, related cable programmes from StarHub's foreign channel partners, and public education problems which give tips on precautions people can take against SARS.

## **21. Principle of Haste:**

Carry out a process or some stages of it very quickly particularly harmful or hazardous.

Fast-reading thermometers are used more widely in order to minimise nurses' contact time with patients.

## **22. Principle of Turning Harm Into Benefit:**

- a. Utilise harmful factors (such as destructive influence of the environment) to gain an advantage.
- b. Eliminate a harmful factor by combining it with another harmful factor.
- c. Boost a harmful factor till it ceases to be harmful.

Singapore authorities try to raise public awareness of the importance of personal and environmental hygiene, and to improve the overall cleanliness of the country. Due to fear of SARS, the campaign appears to be very effective.

Many residents become alarmed when they find out that one of their neighbours may be a SARS suspect and is quarantined at home, which is likely to be next door to them. The government is trying to change this fear into an opportunity by educating the neighbours on SARS (more awareness and education) with the longer-term aim of promoting neighbourliness and bonding amongst neighbours. Bonding will lead to greater civic consciousness.

### **23. Principle of Feedback:**

- a. Introduce feedback.
- b. If feedback is already employed, alter it.

SARS updates and recommendations on many levels (the world, the country the community and the company) may be found in newspapers, TV and radio.

There is a SAR website: [www.sars.gov.sg](http://www.sars.gov.sg) and Singaporeans are all welcome to visit it.

Pamphlets providing travellers with information on the measures taken at Changi Airport to safeguard their health, are available throughout the airport for travellers.

The use of web-based solutions (eg. cameras linked to the Internet) for communication with people who are in quarantine.

### **24. Principle of Middleman:**

- a. Employ an intermediary object as a carrier of an action.
- b. Attach an object to another one, which is easily detachable at the end of an operation.

Many professionals are encouraged to wear protective masks and glasses.

Some supermarkets sell individually wrapped fruits and vegetables.

### **25. Principle of Self-Service:**

- a. Make an object take care of itself, accomplishing auxiliary, maintenance and repair operations.
- b. Utilise a system's waste and unused resources (substance and energy).

School students and employees of many companies measure their temperature a few times a day to monitor their health condition.

Taxi drivers received personal thermometers for fever detection, instead of trooping daily to authorised fever-checking kiosks.

Because of SARS, the hospitality industry (travel, hotels, transportation) is down and many people working in this industry are not doing very much. The authorities use some of the tourist coaches in the hospitality industry to ferry suspected SARS cases from their homes to the hospitals. Using tourist buses also removes the "alarm" that will be caused if an ambulance turned up instead of a tourist bus.

### **26. Principle of Copying:**

- a. If an object is complex, expensive, fragile or uncomfortable in operation, use simplified and low-cost copies instead.
- b. Substitute an optical copy (or a picture) of an object (system of objects) for a real object (system of objects). Utilise scaling (reduced or enlarged copies).
- c. If picture is taken in the visible range, get it in infrared or ultraviolet spectrum instead.

Video- and telephone- conferences with hospital patients rather than the direct visits were introduced from early May

Video- and telephone- business conferences are gradually replacing the face-to-face meetings.

**27. Inexpensive, Short-Lived in Place of Expensive, Long-Lasting:**

Use a set of inexpensive objects instead an expensive one, trading off some of the object's properties (like durability).

Food outlets use more disposable cutlery to minimise cleaning.

**28. Replacement of Mechanical System:**

- a. Replace mechanical system by optical, acoustical or "odour" system.
- b. Utilise electric, magnetic or electromagnetic fields for interaction with an object.
- c. Change stationary fields to mobile fields; constant fields to altering fields; unstructured fields to structured fields.
- d. Utilise fields in combination with ferromagnetic particles.

A new facemask incorporating an additional ionised layer has just been introduced in Hong Kong and is going to be introduced in Singapore soon. It is expected to be more efficient in SARS protection.

**32. Principle of Changing Colour:**

- a. Change the colour of an object or its environment.
- b. Change the degree of transparency of an object or its environment.
- c. If it is required to monitor hardly-visible objects or processes, utilise coloured additives.
- d. If such additives are already in use, employ tracer elements or attach fluorescent markers.

Colour stickers are worn by taxi drivers, hotel and shop staff indicating that they passed the temperature test this morning/afternoon.

Monitoring passengers in Changi Airport by means of comparing their face colour (on the LCD screen connected to the infrared camera) with the threshold picture.

**Conclusion**

This factual analysis of the battle against SARS is certainly incomplete – only the examples related to Singapore were taken into account. Every day brings new actions and new solutions that "utilise" TRIZ Principles. On the 16<sup>th</sup> of May, for instance, one more great example of the soundness of principle 22 (Turning Harm Into Benefit) came to life:

*London-based global financial ratings agency Fitch announced that the Republic of Singapore strong public finances and a proven ability to cope with recent economic shocks such as SARS were the main reasons for its decision to upgrade the country's credit rating from the AA+ to the AAA rating - the highest level in global financial ratings.*

Indeed, the Republic of Singapore did not use the 40 Innovative Principles of TRIZ directly. This study nonetheless reveals that many of the actions taken by the Singapore authorities are enclosed into the suggestions of the 40 Principles. This, in turn, is a good indicator that the Principles are still up to date and might help practitioners in finding sound solutions quicker.

## **References**

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4. Please, visit [www.triz4u.com](http://www.triz4u.com) for more information on the authors.