TRIZ Development Model in China

Author:

Daniel K. Lau, Executive Director, Ralong Business Technology Academy.

Fellow, Institution of Electrical Engineers (IEE), U.K.

Adjunct Professor, University of Electronics Science & Technology of China.

Contact:

Unit 2, 9/F Austin Tower, 22-26 Austin Avenue, Tsim Sha Tsui, Kowloon, Hong Kong.

Tel: (852) 3427 2271 Fax: (852) 3427 2273 Email: daniel.lau@ralong-academy.com

Website: www.ralong-academy.com

Abstract

This paper will discuss a newly developed model, reporting for the first time, called LEADS which is designed to implement TRIZ in China in various stages or phases. The model has been discussed among many local industries and applied in real cases. The author believes that TRIZ will gradually become popular and applied in China as the country is moving into establishing local branded products with local design elements across a wide range of industries. Once the reported success and experience of applying TRIZ in Korea and Japan is shared and made well known in China over the next few years of cultivation period, TRIZ will be starting to together local support and applications. However, the main important issue is to establish a local development model for TRIZ so that a systematic approach for applying the methodology can be referenced. The author will first discuss various initial hurdles in using TRIZ in China based on first hand experience. The various phases of the LEADS model will then be studied together with application to a real case example of a consumer optoelectronics based product. The author has applied various Inventive Principles, Contradiction and S-Field Model.

I Introduction

TRIZ is a powerful tool to generate innovative design. Although it is originated in engineering and technological areas, it is now gradually being applied and the concept being extended into non-technological areas. Despite the fact that TRIZ has been demonstrated as an efficient and effective method in solving problems innovatively, it is still new to many engineers in the world. However, with the gradual adoption in many industrial design applications in the world especially in Asian countries like Japan and Korea in recent years, it is believed that TRIZ will become an essential subject in engineering field within years. TRIZ has started its development in China in the last few years. However today, there are still very few people in China whom are aware of it. One of the main reasons is the lack of a systematic approach to learn and apply this powerful tool.

II Meeting Competition from Globalization with TRIZ

Globalization may bring in a lot of benefits including rapid growth in market size, more opportunity to obtain investment funds, quicker in knowing new technologies which are constantly evolving in the world, better communication to smooth out cultural differences and weakness, etc. However, globalization also brings in the following challenges:

(1) Increases business opportunities also means an potential increase in competition
(2) Since R&D and technology breakthroughs could occur everyday and everywhere, engineers are also competing for innovative level of their designs.
(3) The constant demand for better products with ever lower cost is happening all over the world. Consideration of material used for products and functional capability of products are of essential important to success.
(4) Time to market is getting more critical

TRIZ may be the only systematic tool that can help to meet some of the challenges stated above through the application of the methodology in order to achieve the followings:

(1) Zero defect product at design stage
(2) Innovative and valuable patterns in product / system design in order to bypass short-term and/or mid-term competitions
(3) Patents generation to increase the value of a company, a product or an individual.
(4) Upgrade in the functional capability of a product within short period of time

III Hurdles to use TRIZ in China

Despite the capabilities of TRIZ, there are hurdles to its educational development and application in China within short period of time. Some of these hurdles are outlined in below:

(1) Learning mode in China

    Most Chinese receive knowledge through tradition teaching which is characterized by collecting information / knowledge with minimum analysis of the philosophy behind. Westerners learn through analysis, analogy and brainstorming. Memorization is not an important part in Western mode of learning system. However, TRIZ requires people to be able to think out of local traditions, learn and work in the western style described.

(2) Lack of systematic learning approach

    In western countries, there are many courses aim at providing different levels of TRIZ education and training. In China, there are just a handful of courses on TRIZ and practitioners are extremely limited. At time of this writing, according to informal field information that there are less than 50 TRIZ “advocates” in the mainland with less than 10 TRIZ “advocates and practitioners” in Hong Kong

SAR. Open courses were only available recently.

(3) Lack of attention from executives

TRIZ receives little attention by chief executives because:

(a) They do not know nor have time to understand TRIZ

(b) Too much focus on "time-to-market" issues which reduces a key element in TRIZ, i.e. time for innovation

(c) R&D people are not accustomed to TRIZ and hence reluctant to propose to chief executive on applying this methodology

(4) Lack of resources

TRIZ requires people to think outside the paradigm in problem solving. This requests some initial investment in time and fund from the company, organization or government, as well as individuals. Since TRIZ is new to China, the resources for TRIZ development are still very limited. Time-to-market is rated too important in a product cycle by many SMEs. This hinders many design professionals from trying new concepts because there are more uncertainties than following existing methods or references.

IV The Five-Phases Incorporation Model – LEADS

The fundamental philosophy behind TRIZ is to "jump over" hurdles which prevent a person to think creatively and solve problem innovatively. It is commonly acknowledged that it is vital for local Chinese companies with their design and management teams to become more competitive in the global market in the long run. In order to achieve this goal, TRIZ can be a vital platform for such Chinese companies to stay competitive.

But before we can surf in the arena of creativity, it is however important for us to first understand the cultural differences between the west and China in this context so that a localized implementation model of TRIZ can be realized. To this end, the Author has developed a model called LEADS which covers a five-phase process as below:

(1) **L**earn

TRIZ is simple from its appearance but the philosophy behind is very deep. Learn it by heart before one can really appreciate its power.

(2) **E**valuate

Follow the rules and principles in the first place to solve simple problems so as to get the basic understanding of the algorithms in TRIZ. Learn how to appreciate TRIZ by analyzing the results.

(3) **A**dapt

Incorporate and live with TRIZ to unveil its philosophy. Once you know its philosophy, you may be able to release its real power. . The "Adapt" stage is to train the TRIZ learners to get accustom to solve daily problems with TRIZ that is

to become a basic instinct of the learner.

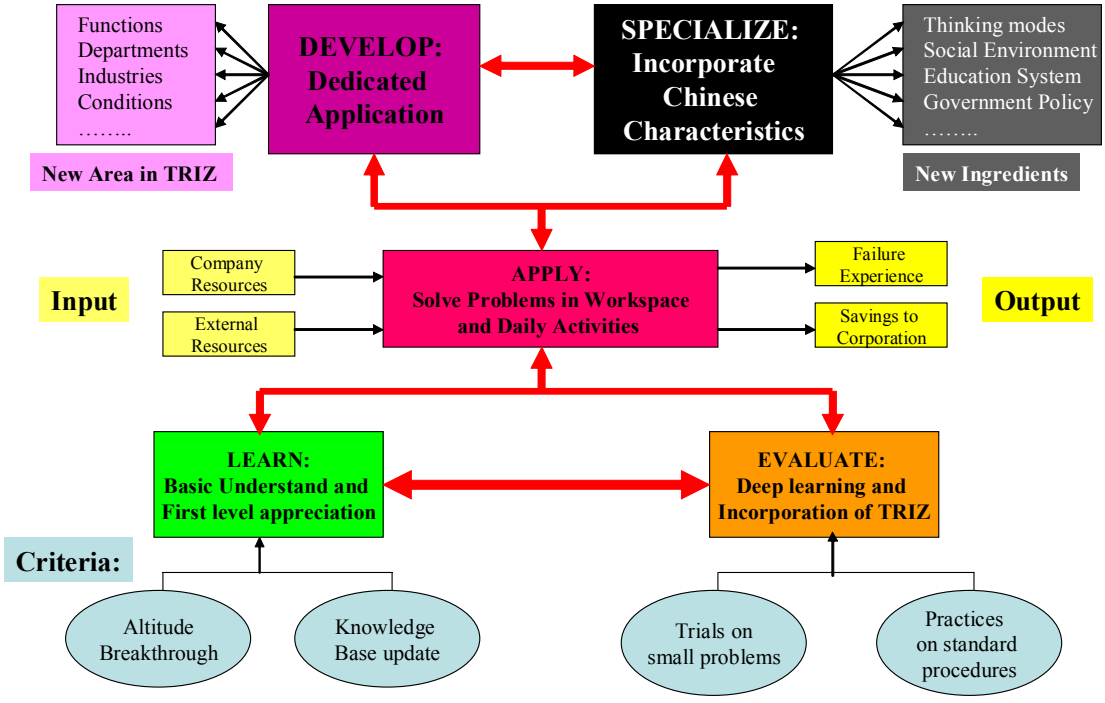
Develop

Tailor TRIZ for specific application segment so that you can modify it to suit the characteristics of yourself and your living environment.

(4) **S**pecialize

Aggregate and trim the modified TRIZ dedicated application environment that can be an individual, a company, an industry, a technical or non-technical arena, a science, a society, a country or even the entire world!

TRIZ Development in China – LEADS Model



V The LEADS Model in Detail

V.1 Learn

TRIZ is powerful tool that is developed by systematic analysis of millions of recorded patents in engineering problems as well as on the analysis of psychological and physiological behavior of human beings on "activities of invention". It is the result of abstract philosophy with empirical proof. In order to acquire an in depth understanding of TRIZ, one needs to adapt different learning approach from philosophy to pure engineering science and with a heart fell trust of the methodology.

(1) The altitude

(a) Be open minded

(i) Chinese are usually more conservative in thinking. This is the main hurdle in learning phase on TRIZ.
- Use more imagination
- Use more analogy

(ii) Be open to ask, discuss and listen from the junior
- Chinese seniors do not commonly appreciate the juniors
- Chinese juniors usually wait for order instead of making proposal

(b) TRIZ is, fundamentally, a philosophy
(i) Technology evolution directly relates to human evolution
(ii) There are different forms of technology which implies that there can different form of "beings"

(c) TRIZ is still growing

(d) Everyone can be innovative

(e) TRIZ starts from Anthropic Principle because it is a study of the human inventive behavior and is evolving gradually to a philosophy on invention.

(2) Thorough understanding on the basic TRIZ
(a) The concepts on
(i) Creativity, innovation, ideality, contradictions and knowledge
(ii) Chinese pays too little attention to understand definition and focus too much on application level, which generate negative effects on innovation.

(b) The tools
(i) Methodology
(ii) Implementation
(iii) Application
- Chinese usually follows application but less trial in new application. This will affect the level of appreciation and real understanding of TRIZ.

(3) Keep updated with the knowledge in the area of interest
(a) The sources of knowledge base
(b) The tools to access the knowledge base
(c) Use analogy to understand a knowledge from different field
(i) Chinese is less accustom to analogy
(ii) Chinese is less confidence on analogy because it usually means that there is not an existing application.

V.2 Evaluate

TRIZ focuses on releasing the ability on innovation of a person. Innovation is not necessarily to be great but must be useful. Therefore in order to build the appreciation of TRIZ power, one must first evaluate his level of understanding on TRIZ through:

(1) The depth of understanding on a particular term, theory, methodology or part of TRIZ philosophy. The deeper the understanding, the more appreciation on TRIZ.
(2) Incorporate the learnt knowledge (may be a small piece only) into daily life, not only just in workspace but also on other daily activities.
(3) The ease of using TRIZ in daily activities reflects the level of incorporation of TRIZ philosophy. This can be self evaluated through the intention and number of occurrences of applying TRIZ in daily activities.

V.3 Adapt

It can be said that the level of understanding of a tool, a skill or a theory will be reflected from the level of application. However, most people, in particularly, Chinese, seldom share experience on failed applications.

(1) Successful application provides positive psychological effects
(2) Analysis on failure application provides knowledge effect because it can reveals
    (i) Deficiency in analyzing the application conditions
    (ii) Deficiency in the scope of application
    (iii) Deficiency in the use of tools, methodology and/or theory
    (iv) Deficiency in the tool, methodology and/or theory itself

    Any deficiency reflects that there is room for improvement or further development. It also provides a direction for the improvement and future development. (This is also one of the reasons for the development of AFD which is a key methodology in TRIZ)
(3) Sharing of experience in failure application accelerate the development of more TRIZ practitioners:
    (i) TRIZ improvement through failure analysis
    (ii) Improvement on application efficiency (no need to repeat the failures)
    (iii) Save energy, time and resources
(4) Apply TRIZ in daily activities to earn practical experience and confidence
    (i) TRIZ application is not limited to solving difficult problems in the workspace but also simple application in daily life.
    (ii) Daily life application of TRIZ provides a wider scope of application environment. This can widen the understanding on TRIZ in different arena. However, most Chinese may think that this is not “high level” enough to be an illustration or sharing with others. This traditional prospective and altitude on learning such a breakthrough, well proven concept must be re-educated.

V.4 Develop

TRIZ is very strong in problem solving and is nearly the unique approach to tackle very difficult design problem. However, the gargantuan scope in problems characterized by their functions, area of occurrences and condition of occurrences will

complicated the use of TRIZ by an individual user. Therefore, it is useful to develop standard model of using TRIZ procedures to use certain TRIZ tools or modified version of TRIZ and its tools in relation to the characteristics of problems:

(1) By function
(2) By department
(3) By industry
(4) By field in science
(5) By fields in non-technological arena
(6) By type of problem
(7) By condition etc

Since solving problems with TRIZ requires the users to know both TRIZ and the specific knowledge involved within the problem, such standard models in dedicated area can then be further develop as a standard procedure or benchmarking criterion in the corresponding area, e.g. TRIZ in Health Care industry, TRIZ in Marketing and Sales, TRIZ in consumer product design etc.

V.5 Specialize

TRIZ originates from Russia and gradually improved by the western world. However, the thinking mode, behavior and culture are different between east and west. For example, many Japanese think that the classic TRIZ is too difficult to be used. Therefore, they developed local TRIZ version called USIT for Japanese companies and local people. [*See Editor's note 1*] The long histories of Chinese will complicated these areas. Therefore, TRIZ development in China can be in the following directions:

(1) Add / amend the components of TRIZ to tailor Chinese
(2) Add / amend the process of adopting TRIZ in China
(3) Add / amend the tools for special application arena in China

VI TRIZ Case Study in China / HK

In 2003, a system company in Hong Kong went through the first three phases (Learn, Evaluate and Apply) of the LEADS model. In 2004, it successfully made use of TRIZ to develop a system project within one year. This system project included proprietary software at system level and a thin client terminal. This section shows how the company incorporates TRIZ in her project development.

VI.1 Introduction

Multimedia content is essential for recreation (e.g. movie, karaoke) and professional

training (all kinds of professional trainings, e.g. lectures on quantum computing). VCD and DVD are the most cost effective and common media to store the content. However from a royalty or intellectual property consideration, they are not good because they do not offer any content protection or interactive features. On the other hand, video streaming methodology from remote server using PC as user access terminal can achieve this content protection objectives but it, on one hand, relies heavily on Quality of Service (QoS) of the network (must be broadband), and on the other hand, require huge investment hardware and maintenance operation on service providers. Moreover, in order to cover the potential market all over the world, there is only one common communication network environment that can serve, i.e. PSTN telephone network system (ordinary telephone network). The project is to set up and demonstrate a system that can serve all these purpose cost effectively in such a way that the multimedia player is just of similar price as the general home entertainment multimedia players.

VI.2 Contradictions on System Level

(1) Ergonomic – Administration Conflict

The solution of the project must be cost competitive in two aspects:

(a) On end user side, the access terminal must be of similar price structure to the ordinary multimedia player commonly found in the market, e.g. high grade DVD player despite the fact that the access terminal is an intelligent device that provides both normal multimedia functions as well as dedicated content royalty protection.

(b) On system and content provider side, the initial investment on hardware and the future maintenance cost must be as low as an ordinary network commonly used by SME.

(c) The whole system must be of high degree of automation but with minimum IT equipments and professionals, but at the same time to be flexible in operation.

(2) Technical Conflict

It has been shown that a broadband network can provide adequate QoS but it requires sophisticated network equipments, broadband network infrastructure and complicated receiver terminal for real time multimedia content access by end users. If the hit rate distribution of end users focus in the same three-hour period of a day (which is true for business deployment), there will be a huge waste of investment on network equipments. On the other hand, a normal multimedia player cannot have any protection on the royalty, and cannot have any interactive services to the end users.

(3) Physical Conflict

Physical conflict is caused by the need of royalty protection on multimedia content and the provision of interactive services with the QoS of broadband. The desired result is to have a broadband network system which can achieve all system requirements and without a broadband network system which requires huge initial investment and operation cost but in limited regions.

VI.3 System Analysis based on TRIZ Substance-Field Model

In system analysis phase, it is necessary to define clearly the problem statement so that all the subsequent design process can be moving in the right direction. This is the result through multiple discussions between the customer and the chief technical officer of the company. In this case, the problem statement is:

> **"Design a system that can handle royalty protection, interactive function and QoS same as broadband on multimedia content with ordinary PSTN telephone network which is same and cover every corner in the world"**

(1) Step 1 : Identify elements in SFM :

System : Multimedia Player with Security Control over Internet
Tool : Multimedia player
Function: Access content, protect royalty, communication on Internet
Substance : Multimedia content player, internet, server system
Field : Electronics (data communication and control)
Environment : Person, display, telephone network
Final Result : Play the content after authentication with broadband quality
Benefit :
Cost :
Parameters :
Analogous Systems :

Figure VI.1 : Identify the elements

- Task – Convey content and control through the Internet

  Function – Convey content and control

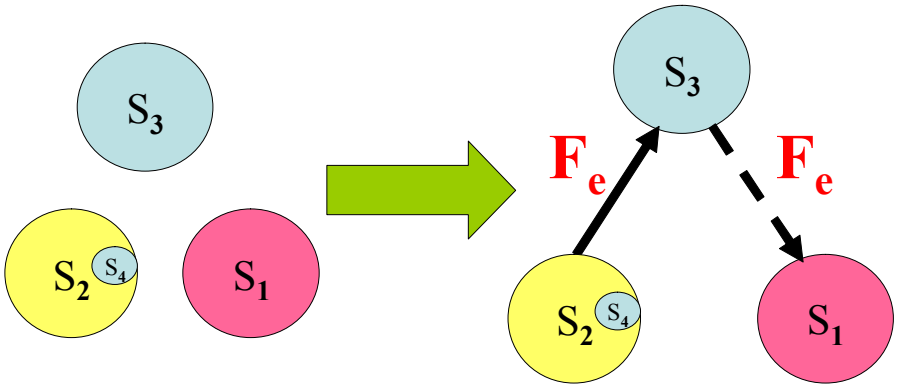
  S1 : Multimedia Player

  S2 : Server

  S3 (Environment) : Internet

(2) Step 2 : Construct the SF model

Figure VI.2 : Construct the model



Remarks:

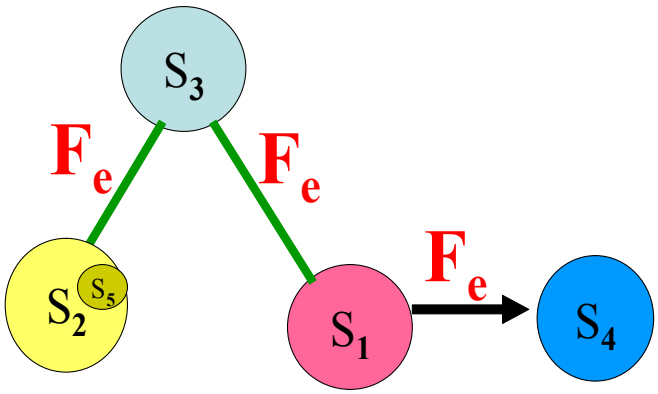
(a) The system is an ineffective complete model because the desired effect (QoS of broadband network) cannot be guaranteed from S_3 to S_2 .

(b) F_e is the electrical force (in the form of electronic data).

(c) Initially, content is within S_2 (system), indicated as S_4 .

(3) Step 3 : Check from the 76-Standard Solution

Figure VI.3 : Consider from 76-Standard Solutions



Using 76-Standard Solutions to change the developed concept into a useful system:

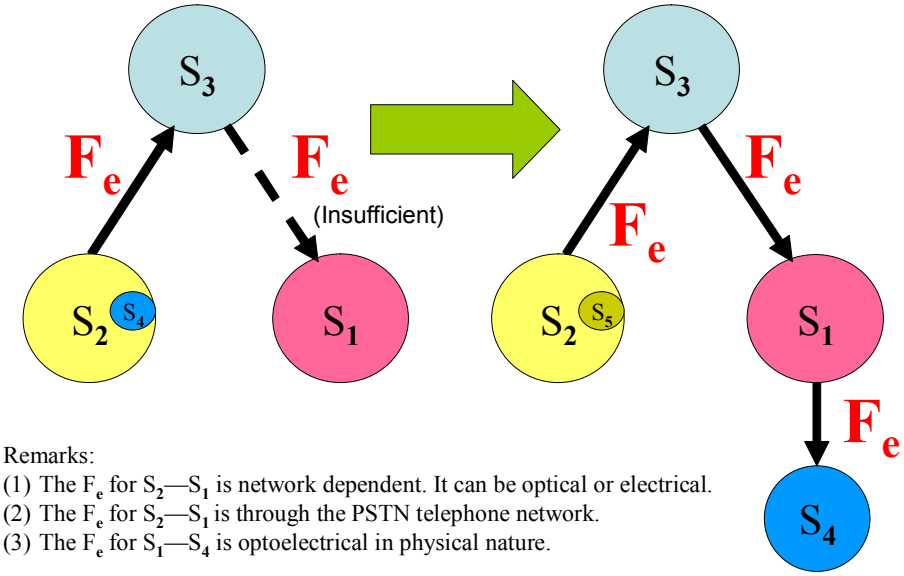
(1) Construction of inner complex SF (Class 1), S_1— S_4 : First is to move S_4 from S_2 to S_1 because network environment cannot be modified

(2) Change in (1) will create an undesired effect, i.e. loss of royalty protection on the content.

(3) Adding substances at SF (Class 5), S_5 within S_2 : Introduce another element S_5 in S_1 to accomplish the loss of royalty protection in (1).

It is unnecessary to set the mechanism in detail at this stage. On the other hand, it is necessary to ensure the mechanism is useful complete system. The SFM model for such system is as follow:

Figure VI.4 : Useful Complete System



Remarks:

(1) The F_e for S_2—S_1 is network dependent. It can be optical or electrical.

(2) The F_e for S_2—S_1 is through the PSTN telephone network.

(3) The F_e for S_1—S_4 is optoelectrical in physical nature.

(4) Step 4 : Develop a concept to support the solution

Checklist for the complete useful system is as follow:

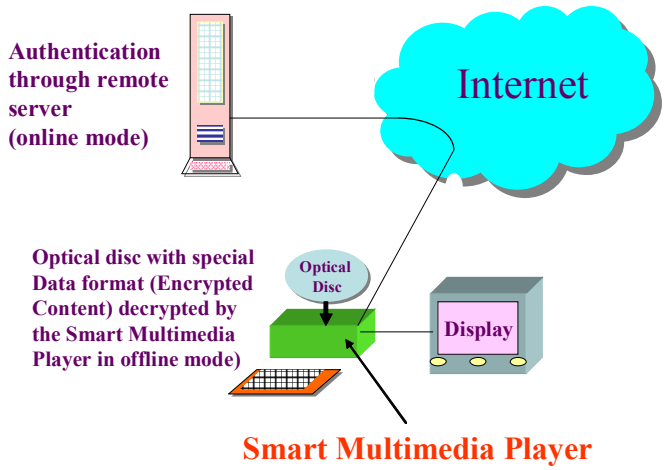
System : Multimedia Player with Security Control over Internet

Tool : Multimedia player

Function: Access content, protect royalty, communication on Internet
Substance : Multimedia content player, internet, server system
Field : Electronics (data communication and control)
Environment : Person, display, telephone network
Final Result : Play the content after authentication with broadband quality
Benefit : Local content to reduce network dependence and authentication via internet to ensure royalty protection
Cost : Proprietary encryption algorithm for content, decryption engine on multimedia player
Parameters : Complexity of the multimedia player
Analogous Systems : DIVX system, e-Media system

The system design based on SFM is as follow:

Figure VI.5 : Security Enabled Multimedia System



Challenges for the success of the system:

(1) Cost of Smart Multimedia Player unit
(2) Time to Market

The multimedia player is the focus of this paper. The next step is to define the specification of the player.

VI.4 Functional Specification of the Multimedia Player

(1) Disk Type : DVD/VCD/CD
  (a) VCD 1.0, 2.0 version
  (b) CD-DA (common music laser CD)

(c) CD-R, CD-RW
(d) MP3 audio CD

(2) Video Format : MPEG2 for DVD; MPEG1 for VCD
(3) Audio Format : MPEG-1 Layers 1,2 and 3 (MP3)
(4) Signal Output : SVGA
(5) Read special format optical disc
(6) Power voltage : AC 90V-AC240V
(7) Power consumption : 25W
(8) V.90+ 56K Modem
(9) Keyboard

VI.5 Contradictions in the Multimedia Player Design

The immediate solution to such a multimedia player is using an ordinary personal computer. However, the contradictions using PC solution includes the following:

(1) Ergonomic – Administration
   (a) Cost
   The cost is too high because the application is dedicated in nature, which violates the versatile application nature of the PC. Therefore, a lot of waste is incurred if PC is adopted.
   (b) Form factor
   PC is of well-defined specification and hence the form factor is nearly fixed. However, for application specific consumer product, the case design is one of the critical factors for success.
(2) Technical
   Compact design has to be employed in consumer product but the functionality needed is a versatile PC.
(3) Physical
   The product specification requires a PC which is large and of standard casing however the application specification requires a consumer product which is small and of non-standard casing.

VI.6 Ideation Function

For an ideal Multimedia Player, it should have the functionality of a PC without being a PC. This will result in a consumer multiplayer player of proprietary casing but with a PC capability and with cost at the same level as the ordinary multimedia players in the consumer electronics market.

VI.7 Analysis based on 40 Inventive Design Principles

Through TRIZ, the 40 Inventive Design Principles are used to solve the technical

contradictions. These inventive principles were used by analogy, to arrive at possible solutions for the captioned problem along the waveguide.

Technical Conflict	**Recommended Principles**
(1) Versatile PC design versus application specific consumer electronics design	#3 Local Quality #2 Extraction #3 Merging #17 Another Dimension
(2) Play general multimedia data format as well as proprietary data format	#1 Segmentation
(3) Standard casing versus proprietary casing	#15 Dynamicity #17 Another Dimension

VI.7.1 Analogy of the Inventive Principles

Employ analogy to match the principles to the current problem as follow:

(1) #3 Local Quality
   (a) Change from uniform to non-uniform structure for the PC related functions
   (b) Change from uniform to non-uniform structure for the external environment, the casing

(2) #2 Extraction
   (a) Only the necessary part of the PC hardware functions are included, e.g. no Ethernet interface, no floppy drive
   (b) Only the necessary part of the PC software functions are included, e.g. modify operating system (OS) for standard PC.

(3) #5 Merging
   (a) Bring closer together the PC operations in space
   (b) Bring closer some of the records on system side to user side, e.g. user records on the proprietary content stored on the Multimedia Player instead of on the system side.

(4) #1 Segmentation
   (a) Separate the multimedia content from within the hardware to be external of the hardware and become a separate object.
   (b) Separate the decryption engine from the engine of reading normal DVD or VCD to another program module.

(5) #15 Dynamicity
   (a) Replace flexible mechanical casing design for general upgrade to inflexible compact mechanical design

(b) Remove all expansion slots for product upgrade

(6) #17 Another Dimension

(a) Go from single layer to multi-layer, for circuitry and components

(b) Go from single storey to multi-storey on the subsystems

VI.7.2 Recommendations on Design based on the Inventive Principles

Employ analogy to match the principles to the current problem as follow:

(1) #3 Local Quality

(a) Change from uniform to non-uniform structure -- from versatile design to embedded design using single compact microcontroller instead of several high performance processors for the PC main control.

(b) Change from uniform to non-uniform structure for the external environment, the casing – use proprietary case with form factors as specified by the customers as far as possible.

(2) #2 Extraction

(c) Only the necessary part of the PC hardware functions are included, e.g. no Ethernet interface, no floppy drive – Remove all such circuitry from the host controller board

(d) Only the necessary part of the PC software functions are included, e.g. trim (also TRIZ tool) down the ordinary operating system (OS) for PC to a smaller and application specific OS.

(3) #5 Merging

(e) Bring closer together the PC operations in space – e.g. the video driver, decoders and network interface all within the same host board.

(f) Bring closer some of the records on system side to user side, e.g. user records on the proprietary content stored on the Multimedia Player instead of on the system side – a separate and protected record data record area reside on the multimedia player for system operation only.

(4) #1 Segmentation

(g) Separate the multimedia content from within the hardware to external to the hardware and become a separate object – Store the content in an optical disc. Access it only when needed.

(h) Separate the decryption engine from the engine of reading normal DVD or VCD to another program module – It is conditionally activated after confirming that the content within the optical disk is of the proprietary format.

(5) #15 Dynamicity

(i) Replace flexible mechanical casing design for general upgrade to inflexible compact mechanical design – Remove all the designs that allow user to open the case for any repair work.

(j) Remove all expansion slots for product upgrade – Remove the circuitry for the all expansion slots not needed.

(6) #17 Another Dimension

(k) Go from single layer to multi-layer for circuitry and components – e.g. design with the use of multilayer PCB for circuit routing and have components to be mounted on the top and bottom layer of the PCB.

(l) Go from single storey to multi-storey on the subsystems – e.g. stack up the host board, DVD mega and the memory assembly (three layers).

VI.8 Anticipatory Failure Analysis and Trimming

AFD serves to predict the potential failure mode and their results within the system, and then conduct improvement evaluation when the system is still on the paper design stage OR during prototype stage only. It is based on AFD that the paper design or prototype can then be improved or re-designed in order to remove any potential failure modes which may occur within the system while it is still at design or prototype stage. Hence AFD is aimed to anticipate system failure before the system is put to real live deployment application.

(1) Problem Statement: What are the ways to produce failure in the multimedia player?

(2) Potential failure modes (Methods to produce failure):

(a) System Failure

(i) User cannot send ID to remote control server for the authentication due to modem failure.

(ii) Master controller for web serving services malfunctions.

(iii) Breakdown on the video stream from optical storage media (DVD, VCD or CD) to the MPEG decoder circuitry through the DVD loader.

(iv) MPEG decoder circuitry malfunction

(b) Inadequate function

(i) Dial-up modem interface limits the performance of general web serving.

(ii) Boot up time from flash memory will be very slow and may also destroy user data.

(c) Inadequate performance

(i) Single board design allows reduction of PCB cost by an amount of

US$0.5 but rules out the possibility of standalone hardcore platform to integrate with other network interface to form new products, which enhances cost reduction on the electronic components purchased.

(ii) X86-based microcontroller (486 grade) simplifies hardware design and software programming but slow in speed, especially during bootstrap phase.

(3) Resources for the failure

(a) System failure

(i) Modem chipset is not reliable and MTBF is short.

(ii) Master processor is not powerful enough to serves those website that pump continuously refreshed video signal to the player, e.g. game website.

(iii) DVD loader is noisy, not reliable and MTBF is short.

(iv) MPEG decoder chipset malfunction or the S/N is too small in a compact environment.

(b) Inadequate function

(i) Master processor is not capable enough to handle the service requested by the cable modem.

(ii) Access time of Flash memory is too slow to handle the boot up sequence and subsequent manipulation on the high speed and tremendous data.

(iii) Thin client miss the resource for possible future service upgrade through common user interface.

(c) Inadequate performance

(i) Single board design cannot serve the need for product variances to low down the main cost of materials, i.e. processors and other ICs.

(ii) The next generation x86-based microcontroller rolls out a year from the design deadline and is not 100% compatible with the current design.

(4) Hypothesis on the mechanism for the failure

(a) System failure

(i) When master processor cannot handle the function properly, it will execute a hardware exception and come to a system halt.

(ii) Since master processor cannot properly handle the graphics objects, program error arises or graphics objects are displayed as characters improperly.

(iii) DVD loader generates noise that affects data integrity before and after MPEG decode. In addition, it may become malfunction during service warranty if its MTBF is too short.

(iv) Too high ambient temperature, mechanical damage or electrical shock.

(b) Inadequate function

(i) Bandwidth of dial-up modem is too small to cater for the continuously refreshed video data pumping from the server side through the internet.

(ii) The boot up time is too long and will also introduce system instability.

(c) Inadequate performance

(i) When only the network interface is requested to change, need redesign of the schematic and whole PCB layout. It incurs excessive time and additional cost.

(ii) Using x86-based microcontroller will degrade the general web-surfing performance.

(5) Hypothesis verification

(a) System failure

Simulate the timing diagram for the master processor based on the function needs to perform, which include dial-up modem interface, data extraction from telephone network, data stream transportation for MPEG decode, 2D graphics decode, interface with flash memory for device setup etc. A good practice in estimation of the performance is to reduce the capability of the master processor by 30% and raise the loading of each function by 20%.

(b) Inadequate function

(i) Inadequate function item (i) cannot be solved with existing resources within the design.

(ii) Boot up time for flash memory can be calculated by simulating the timing diagram for the boot up sequence needed for the system. A good practice in estimation of the performance is to reduce the capability of the master processor by 30% and reduce the access time (Read and Write) for flash memory by 20%.

(c) Inadequate performance

(i) Estimate the cost difference based on 1000 sets of the boards.

(ii) Closely follow up with the supplier of X86 microcontroller for the new and more powerful microcontroller.

(6) Corrections on failures

(a) System failure

Replace the master processor with Pentium 2 core based micro-controller with built-in 2D graphics engine (e.g. P2 microcontroller from SGS Thomson). Estimated price will be U$10 higher than the current design but the processor capability will be at least double. Such microcontroller is of Ethernet interface.

(b) Inadequate function
    (i) Stress on the application specific purpose of the multimedia player.
    (ii) Use One-time-PROM (OTP) to replace flash memory for system software. Flash memory is used for user data only.
    (iii) For additional user interface, add USB port for future hardware connection by end user.
(c) Inadequate performance
    (i) Use Separation Principle, Separation of Space, to separate the single board design into two, the backend (main board) and the front end (network interface) with Ethernet as the standard interface between them.
    (ii) Replace by P2-grade microcontroller.

(7) Result Evaluation

The modified design is of the following features:

(a) Master processor changes from 486-based X86 core to P2 core (200MHz).
(b) Add the 3D graphic engine (to handle all common graphics objects)
(c) Add interfaces (USB and IDE) for future hardware (e.g. printer and micro-drive) attachment.
(d) Separate the design to backend and front end in such a way that by changing the network interface front end (e.g. cable modem, ADSL modem etc), the thin client can immediately serve other applications (versatile design). This can lower the component cost of the backend significantly.

VI.9 New Knowledge Acquisition – Enrich the Knowledge Base

At the end of the project, it is necessary to update the knowledge base learnt or obtained. Despite the fact that some of the Inventive Principles and/or recommendations are not actually applied in the final design, it is valuable to record down them so that it may be used or referred in the future through a feasible searching process from the knowledge base. It is worth to mark down the knowledge that has been tested and untested to distinguish the "depth on knowledge acquired".

(1) Various encryption and decryption engines
    (a) Lossless Compression / Encryption Techniques
        (i) Run Length Encoding (RLE)
        (ii) Lemple-Ziv-Welch Encoding (LZW)
        (iii) Huffman Coding
    (b) Lossy Compression / Encryption Technique
        (i) Scalar Quantization
        (ii) Rate Distortion
        (iii) Transform Image Coding Scheme

- Rectangular Wave Transform
- Eigenvector-based Transform
- Wavelet Transform

(2) Communication Protocol Design
   (a) Triple Data Encryption Scheme (Triple DES)
   (b) GOST Scheme
   (c) Message Digest 5 (MD5)

(3) Cryptography for authentication process
   (a) Cipher System
   (b) Data Encryption System (DES)
   (c) Public Key Crypto System
   (d) The Rivest-Shamir-Adelman (RSA) Scheme
   (e) Stream Encryption System

VI.10 Design Project Conclusion

This project presents TRIZ application in electronics system design. The system is completely new to the Company. Despite the fact that only some of the TRIZ tools are employed. It is easily found that the system is a directly follow up of the customer requirements. TRIZ SFM is good for system modeling while upon reaching the product specification, Contradiction Principles and 40 Inventive Design Principles will become much useful to have the design become focus on to the application. Finally, the AFD and Trimming techniques are used to debug and modify the design to the real prototype which is very much close to the real product.

VII TRIZ Localization

It is out of question to suspect the effectiveness of TRIZ towards problem solving. However, some people find that TRIZ is difficult to use because there are no mathematical rules to guide the innovation process. This is true at user level. One of the reasons is that creativity and innovation are abstract human behavior. At user level, this is meaningless to present innovation by empirical formulae because if this confinement is added, designers cannot solve problem innovatively anymore. However, the philosophy aspect behind TRIZ can be presented by abstract mathematics, including set theory and topology etc.

On the other hand, there are specific characteristics within China that can affect the efficient implementation and application of TRIZ, e.g. learning habit, working style, environmental and situational differences, resources availability, cultural difference etc. Together with the fact that TRIZ is human behavior related, therefore, similar to Japan, TRIZ localization in China will be inevitable in the future.

VII Conclusion

TRIZ is a very effective and systematic methodology to train up people to use their inherent innovative capability to solve design problem. Chinese is characterized by their strong learning and adapting ability. Moreover, China has been the well known manufacturing bases of the world in the past decade. Nowadays, many manufacturers are seeking ways and opportunities to transform from OEM business model to ODM. The transformation requires breakthrough in design capability in multiple aspects from basic product design, manufacturing design and testing design to more sophisticated operation model design, marketing model design and financial model design etc. TRIZ is proved to be successful in many multinational corporations all over the world. With the specialized LEADS model described here for the first time, TRIZ can be deeply interwoven with the economic activities of China within years.

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Editor's Notes

1. SIT was developed in Israel in the 1980's. USIT was developed by Ed Sickafus in the US http://www.ntelleck.com, and has been adapted for use in Japan by Toru Nakagawa (see his paper in this issue of the TRIZ Journal.) However, there are many companies in Japan using TRIZ, not USIT. See the November 2003 issue of the TRIZ Journal, for example, for a report on the 4th Invention Machine Users Group conference, and see the numerous papers from the Sanno Institute and from authors working at Hitachi, Fujitsu, etc.

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6) "Beyond TRIZ Limits", TRIZ Journal, March 1998, Denis Cavallucci and Philippe Lutz
End…