2019

GCSI

The 9th Global Competition on Systematic Innovation

Your outstanding innovation deserves Global Recogitions in the International Arena!

Project Briefing

July 8 - 11, 2019, Liverpool, UK
The University of Liverpool Management School

Co-Organizers :
International Society of Innovation Methods (I-SIM)
The Society of Systematic Innovation (SSI)
The University of Liverpool Management School (Local Host)
Nottingham University Business School

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Message from the Chair of GCSI

Dear Colleagues and Guests,

On behalf of the local organizing committee and I-SIM, it is my great pleasure to welcome you to Liverpool, for participating the 10th International Conference on Systematic Innovation (ICSI) and the 9th Global Competition on Systematic Innovation (GCSI). The idea to host the GCSI was born from within the TRIZ community in Taiwan and was rapidly joined by scientific interest groups from the USA, China, Hong Kong, Thailand, Japan, UK, France, Korea, Portugal and Russia. The goal of the GCSI is to share and disseminate newly developed methodologies on systematic innovation and its applications.

The unique feature of the GCSI, which distinguishes it from other innovation competitions, is that it stresses the systematic process of innovation. Specifying the systematic process of innovation ensures that the authors do not miss crucial steps in innovation, thereby making it more fruitful. The GCSI 2019 will foster discussions and hopes to inspire participants from a wide array of themes to initiate collaborations within and across disciplines for the advancement of our field. We welcome all of you to attend the GCSI presentations and invite you to interact with the conference participants and join our social activities.

We thank the local staff, participants and judges for helping us to build this very exciting conference program. The GCSI organizing committees will devote all possible effort to ensuring that your participation will be scientifically rewarding and that you have a pleasurable experience in our venue region, which is rich in ferries, galleries, cathedrals, manor houses and history.

Best Regards,

Jyhjeng Deng

Chair, the 2019 GCSI
Chair Professor, Department of Industrial Engineering and Management
DaYeh University, Taiwan
Email: jdeng@mail.dyu.edu.tw
July 9, 2019

GCSI Briefing

The 9th Global Competition/Exhibition on Systematic Innovation (GCSI)
Outstanding innovation deserves global recognition.

I. Co-organizers:

- International Society of Innovation Methods (I_SIM)
- The Society of Systematic Innovation (SSI)
- The University of Liverpool Management School (Local Host)
- Nottingham University Business School

II. Background and Objectives

Systematic Innovation is a field of knowledge, practical tools, and processes which can enable us to systematically identify innovation opportunities and/or arrive at innovative problem solutions. To date, the great majority of innovation ideas come from brain storming type of random processes or spontaneous genius. Both of the situations are either hard to come by or highly unpredictable. In addition, they do not expose us to a full solution space for us to choose the best available solutions. **Although, the results are important, the processes to generate the results are vitally important to determine if the desirable results can be achieved reliably.** Systematic Innovation knowledge and tools provide systematic processes to enable humans to identify opportunities and solve problems reliably. However, the existing invention/innovation competitions all focus on the results with no consideration at all on the process of generating ideas.

In this highly competitive world, innovation is a survival necessity. We believe that Random Innovation can only help companies to survive but not to excel. **To excel, a company needs to deploy systematic innovation!** It is believed that "Innovation may be accidental, systematic innovation is destined".

The goals of this global exhibition/competition are to promote systematic innovation and help the proliferation of innovation results. In order to nurture the ability to generate innovative ideas reliably and to see the full solution space of problems, **the Society of Systematic Innovation (SSI) established the world's only Global Competition on Systematic Innovation (GCSI). You participation of project competition is cordially invited.** Innovations/Inventions are all welcome. Multiple medals and certificates will be awarded to a number of winners.

The GCSI is organized in corporation with the "International Conference on Systematic Innovation"**)** where papers are presented.

III. Special Features Of The Competition

The GCSI is established with the below distinguishing features:

A. Both "Opportunity Identification" and "Problem Solving" types of projects are valued.

In fact, "identifying the right thing to do" is far more important than "doing the thing right". As such, in addition to "Device Innovations", "Process Innovations", "Service or Business Model Innovations" are all valued.

B. Both results and idea generating processes are accounted for in the evaluation of each project.

In all the existing invention or innovation competitions, only the results are evaluated. The Society of Systematic Innovation believes random innovation can only produce sporadic results probably good for survival. To excel in the competitive world, establishing and maintaining a sustainable and consistent strong flow of innovation is needed. Promoting systematic innovation is the way to institutionalize an innovation culture. The Process of doing the systematic innovation is the long-term guarantee of sustainable innovation results.

Project Presentation Sessions

09 July 2019 15:00-17:00
Location: Seminar Room 1, South Campus Teaching Hub (SCTH) Building

Time	ID	Project Title	Team member(s)
15:00-15:20	11	Innovative Product Development for Pressure Vessel	Mei-Hwa Chen, Hsin Rau
15:20-15:40	14	A Portable Seating Assist Device	Yu-Gang Chen, Jo-Peng Tsai
15:40-16:00	15	New Approach to Respiratory Rate Monitoring Device using TRIZ	TriZit Benjaboonyazit, Tayard Desudchit
16:00-16:20	17	Multifunctional integrated desk and chair	Pei-Hsi Liu , Zheng Hao Chen, Meng Wei Ye , Zi-Qi Liu, Chen-Hui Wu, Sheng, Xie-Zhi
16:20-16:40	12	TRIZ++ Methods to solve white spots problems in wafer manufacturing processes	Hsuan-Yi Wu, D. Daniel Sheu, Jealousy Hong
16:40-17:00	16	New product identification and design using affinity measures and super-system trimming: Example of Multi-functional Stick	Dongliang Sheu, Chia-Lin Ho

10 July 2019 14:10-17:00
Location: Seminar Room 1, South Campus Teaching Hub (SCTH) Building

Time	ID	Project Title	Team member(s)
14:10-14:30	5	AI-based engineering problem solver	Aleksei Ruin
14:30-14:50	6	A Powder Circulating Short Tube Air Dryer	Chuan He, Tianji Zhu, Fan Shi, Jiahao Li
14:50-15:10	7	Microwave Weeding System	Darrell Mann, Kobus Cilliers, Shreyas Bakshi, Parag Raut
15:10-15:30	8	MyDietDay: An Alternative Solution to Obesity, Overweight, and Maternal Based Websites to Improve Healthy and Effective Diet	Indri Hafida, Linda Arum Sari, Mohammad Afan Setyadi, Muhammad Zaini Rahman, Alfredo Juan Pratama
15:30-15:50	13	Handy Deskmate —An Innovative Design of Desktop Organizer	Tien-Lun Liu, Ming-Cheng Tsai, Hung-Huai Shen, Ling-Hsiang Hsieh
16:00-16:20	9	Loborats (Lombok Boat Rapid Transit System) Integrated Tourism Crossover Services as an Innovation to Easily Access of Passenger Movements	Olga Putri Sholicha, Refiantika Rachma Utami, Rudi Haryanto, M. Bayuni Ilham
16:20-16:40	3	Geographic Information System (GIS) in Amalin.id as a volunteering and social crowdfunding system	Mohammad Afan Setyadi, Muhammad Syarifuddin, Baharudin Yusuf Widiyanto, Gerwin Jonathan Henri
16:40-17:00	19	Based on the Innovation Case of ARIZ-85C Sprout Cultivation Machine	Demou Zheng, Daohua Xu, Kaiqin Xu, Yiqiang Wang

Project List

ID	Project Title	Team member(s)	Country
3	Geographic Information System (GIS) in Amalin.id as a volunteering and social crowdfunding system	Mohammad Afan Setyadi, Muhammad Syarifuddin, Gerwin Jonathan Henri, Baharudin Yusuf Widiyanto	Indonesia
5	AI-based engineering problem solver	Aleksei Ruin	Belgium
6	A Powder Circulating Short Tube Air Dryer	Chuan He, Tianji Zhu, Fan Shi, Jiahao Li	China
7	Microwave Weeding System	Darrell Mann, Kobus Cilliers, Shreyas Bakshi, Parag Raut	UK, India
8	MyDietDay: An Alternative Solution to Obesity, Overweight, and Maternal Based Websites to Improve Healthy and Effective Diet	Indri Hafida, Linda Arum Sari, Mohammad Afan Setyadi, Muhammad Zaini Rahman, Alfredo Juan Pratama	Indonesia
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13	Handy Deskmate －An Innovative Design of Desktop Organizer	Tien-Lun Liu, Ming-Cheng Tsai, Hung-Huai Shen, Ling-Hsiang Hsieh	Taiwan
14	A Portable Seating Assist Device	Yu-Gang Chen, Jo-Peng Tsai	Taiwan
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Project ID: 3
Project Title: Geographic Information System (GIS) in Amalin.id as a volunteering and social crowdfunding system
Team member(s): Mohammad Afan Setyadi, Muhammad Syarifuddin, Gerwin Jonathan Henri, Baharudin Yusuf Widiyanto
Organization/Dept: University of Brawijaya

Project Briefing

I. Motivation and objectives

Amalin.id is a crowdfunding website focused in charitable activities and volunteering projects for various social, personal, creative, and other purposes situated in Indonesia. Amalin.id is committed to providing an online platform and services for individuals, communities, organizations, or companies who wish to:

1. Organize crowdfunding campaigns by creating online donation pages for various social, personal, creative, and other purposes.
2. Donate anytime online to campaigns they care about. With the strong national spirit of working together in doing good deeds.
3. Sign up to volunteering activities for humanitarian aid projects.

We, Amalin.id, will always do our best in improving our technology and services. Making it even easier for people to organize crowdfunding, charity, volunteering activities online and reach more people in Indonesia.

II. Features of the project

Amalin.id has several useful features:

(1) Volunteer System, as an intermediary facility for people who want to be directly involved in helping society who are suffering from disaster.

(2) Free charity, as a dedication from Amalin.id to help people who are in need for help by removing administrative fees by 5% to 0% for certain categories.

(3) Realtime notification, as a support facility for volunteers and campaigners in conveying their good intentions.

(4) Geographic Information System (GIS), to help good people find the location of people who need help. Where this location was previously shared by the campaigner.

(5) Based on Progressive Web App (PWA), everyone can install Amalin.id on their Android and iOS devices.

III. Value and Contributions

We hope that Amalin.id can provide several benefits and contributions to society, such as:

1. Making it easier for people to be involved in charity

   Using Online Charity system, it is easier more than ever to do charity transaction anywhere, anytime, with the services provided by Amalin.id.

2. Helping people living in poverty and disaster victims

   People face struggles in their lives and need help. There are kids who stopped studying in school for financial reasons, people living below the poverty line, and people who affected by natural disasters. Amalin.id provides the platform to give financial and volunteering help to those people in need.

3. Helping to create better society

   Being the platform for charity and volunteering activities, Amalin.id will help creating good relations between people on the basis of helping others in need.

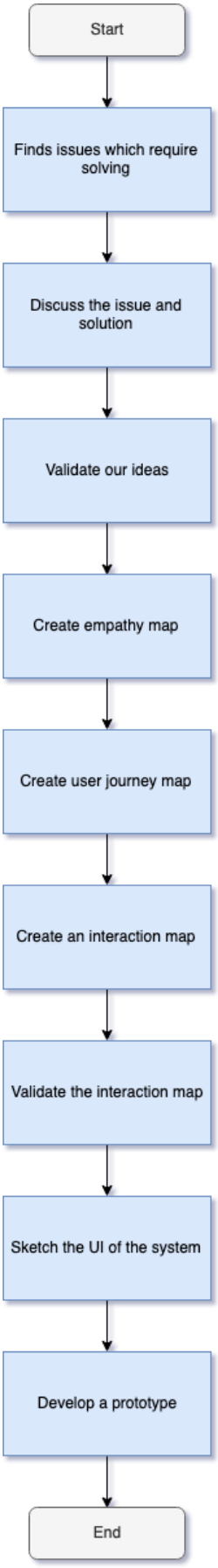
IV. The ideas generation process

Our steps for ideas generation:

1. Each member of our team finds issues which require solving.
2. Discuss the issue and brainstorm for feasible, viable, and desire able solution.
3. Validate our ideas to the real user using interview method and filling out user validation form.
4. Create empathy map in order to identify target audiences which will be useful to match our business strategy and value proposition with user's desire, need, purpose, and feeling.
5. Create user journey map in order to picture the relations and interactions between users and our system.
6. Create an interaction map that helps us to sketch out the UX and forecast any friction before creating the actual website or prototype.
7. Validate the interaction map we made with user candidates through interview.
8. Sketch the UI of the system that will be made.
9. Develop a prototype system.

This is our ideas generation process documentations. We created it in Indonesian.


Bermanfaat Bagi Sesama
Bersama Amalin


Start
Finds issues which require solving
Discuss the issue and solution
Validate our ideas
Create empathy map
Create user journey map
Create an interaction map
Validate the interaction map
Sketch the UI of the system
Develop a prototype
End

Project ID: 5
Project Title: AI-based engineering problem solver
Team member(s): Aleksei Ruin
Organization/Dept: Innovating Cloud

Project Briefing

I. Motivation and objectives

About 3 years ago we started developing a crowdsourcing software platform which functioned as a sophisticated but sexy-looking idea bucket. We have launched a few crowdsourcing campaigns, have collected our first thousands of ideas and when I, a project-starter and a platform admin, carefully analyzed them I felt what Barak Obama called a "sputnik moment" in 2010. This was the first time when I received a rock-solid evidence of how desperate the human beings are when a crowdsourcing problem or any other type of a problem is crying for a creative solution. "They" (in fact I must say us) are hopeless, "they" submit shallow ideas, spam, irrelevant ones or ignore the campaign requests. For us it was a trigger to start thinking about an automated version of "they". This AI-based solver should:

- Receive a textual description of an engineering problem. About 200-300 words presenting the engineering system which sucks, the context, existing alternative solutions and their disadvantages and the problem itself.
- AI, a set of neural networks in fact, should "understand" the hidden hints telling how exactly this problem wants to be resolved. This knowledge should come from a huge dataset connecting an engineering problem with a creative solution on which the networks will be trained.
- Present the solutions as a text first and as a sketch/drawing on the later project stages.

II. Features of the project

- This automated solver generates ideas instantly and is always on. No ignoring.
- The proposed solutions are always strong. Always creative and relevant.
- Uses user input for constant updating the dataset and re-training the networks. A "hidden" crowdsourcing exercises aim at improving the classification accuracy.

III. Value and Contributions

- The software can co-exist or replace the existing crowdsourcing platforms. Since our

solution can provide THE answer to a problem there will be no need to gain large human idea contributor masses for reaching the same result via "ideators mass inflation". Having 1 (one) account is way more cost-efficient than a thousand.

- Individual users can also win. Using the solver might be viewed as having an "innovation guru", a virtual all-mighty ideation Teacher, an "innovation Merlin" which is always next to you ready to share his wisdom. Whichever engineering challenge an individual user is facing in his/her office or after working hours – the automated solver will always help.

IV. The ideas generation process

I am a 4th level MATRIZ certified TRIZ practitioner with 10+ years of experience under my belt. Being a TRIZ trainer at GE, Siemens, Alcoa and many other companies I dealt a lot with very different engineering tasks and their solutions. So what I have collected during all these years is a big though completely unstructured database of strong TRIZ solutions. This database became the begging of all this project. We clearly saw the problem of all the crowdsourcing platforms on the planet (aka idea management software) – low idea quality. You can use a duct tape for solving this fundamental problem: idea comments, voting/likes and other tools to develop new ideas on others creative crap or you can attach the very root cause. The Cause-n-Effect Chain Analysis TRIZ tool here is very quick – the key problem is us, it is us, the human beings, who are the reason for having low idea quality in the crowdsourcing campaigns. As it was already mentioned above, we should be excluded out of the ideation process.

Project ID: 6
Project Title: A Powder Circulating Short Tube Air Dryer
Team member(s): Chuan He, Tianji Zhu, Fan Shi, Jiahao Li
Organization/Dept: Hebei University of Technology

Project Briefing

I. Motivation and objectives

With the rapid development of social economy and the increasing energy consumption, it has become an important issue for sustainable development and improve energy utilization efficiency. Drying operations involve a wide range of areas of the national economy. The energy used in drying accounts for about 12% of the total energy consumption in the national economy, and the annual growth rate is about 5%.It is an urgent task to develop a drying technology and an equipment with efficient and energy-saving feature.
Lithium manganate, the powder material of lithium batteries, needs to be dried. The humidity of powder before drying is about 0.5%, and the requirement of humidity after drying is less than 0.01%. The traditional powder dryer is a high tube air dryer. The high tube air dryer is 15 to 20 meters high.
The main task of this project is to reform the structure of the dryer, which mainly solves the problems of high height, high power consumption and uncontrollable drying effect of the air dryer.

II. Features of the project

(1) Low energy consumption
(2) The structure is simple
(3) Easy to manufacture and install
(4) Easy to clean
(5) Controllable drying effect

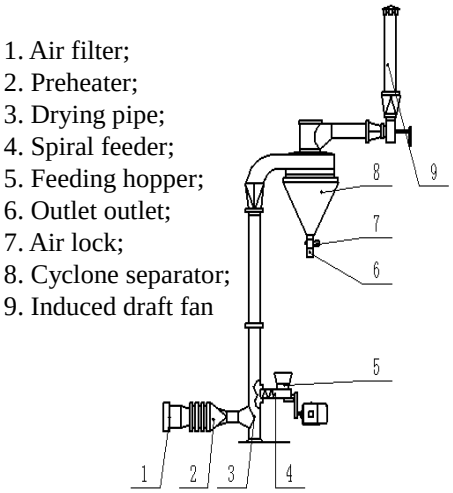
III. Value and Contributions

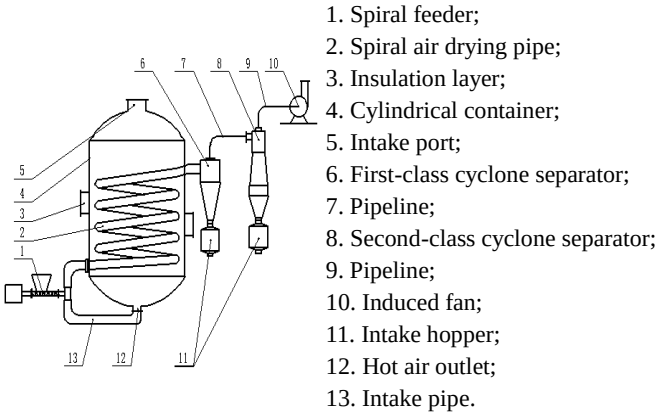
(1) Reduce the height of the dryer, making maintenance and installation convenient. Low requirement for installation space. The manufacturing cost is low.
(2) The internal structure is simple without cyclone separator. It is easy to manufacture and clean.
(3) The inner part of the dryer circulates with low power consumption and high energy utilization.
(4) The weighing device determines the feeding quantity, improves the working efficiency and drying quality.
(5) Powder is circulated in the dryer to control the drying effect.

IV. The ideas generation process

1 Problem statement
Powder and hot air enter from the bottom of the dryer. Hot air passes through air filter and preheater respectively before entering. Powder is added by screw feeder through feeding hopper . Hot air contacts with powder fully in the dryer and exchanges heat achieve vaporize the liquid. The air

separator is separated from hot air and volatile water, and discharged from the outlet through the air lock .In order to ensure the drying effect, it is necessary to increase the drying time, which leads to the high height of the dryer; the high dryer is difficult to process; and it is difficult to install the high dryer; the height of the dryer is fixed, the drying time can not be changed; the installation and cleaning





of the high tube is inconvenien. See figure 1 specifically.

Figure 1 Working principle of high tube Dryer Figure 2 Spiral tube air dryer

In order to reduce the height of the dryer, the method of installing spiral air dryer in cylinder is adopted. The height of the dryer is low, but the inner structure is complex and cleaning is inconvenient. See Figure 2 specifically.

2 System analysis

2.1 Function analysis

Establish the function model of the system, as shown in figure 3.

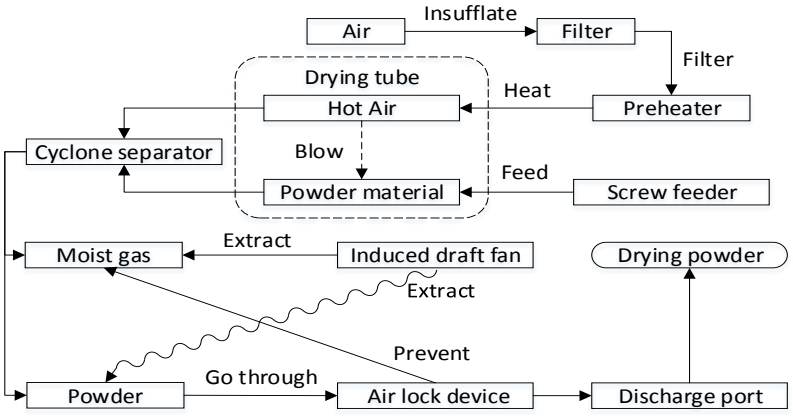


Figure 3 Function model

Insufficient: In the process of upward flow in dryer, water in powder should be vaporized as far as possible, but the length of dryer is certain, and the moisture of powder may not reach the demand after one drying.

Harmful: When powder need to be gas-solid separation, it is necessary to make the wind speed decreases, but the induced draft fan sucks air to increase wind speed, and may cause powder to be brought out by moist gas.

2.2 Root cause analysis

Aiming at the problems existing in the function model, the root causes of the problems are analyzed. The reason why the height of drying pipe is too high and the drying effect is difficult to guarantee is analyzed.

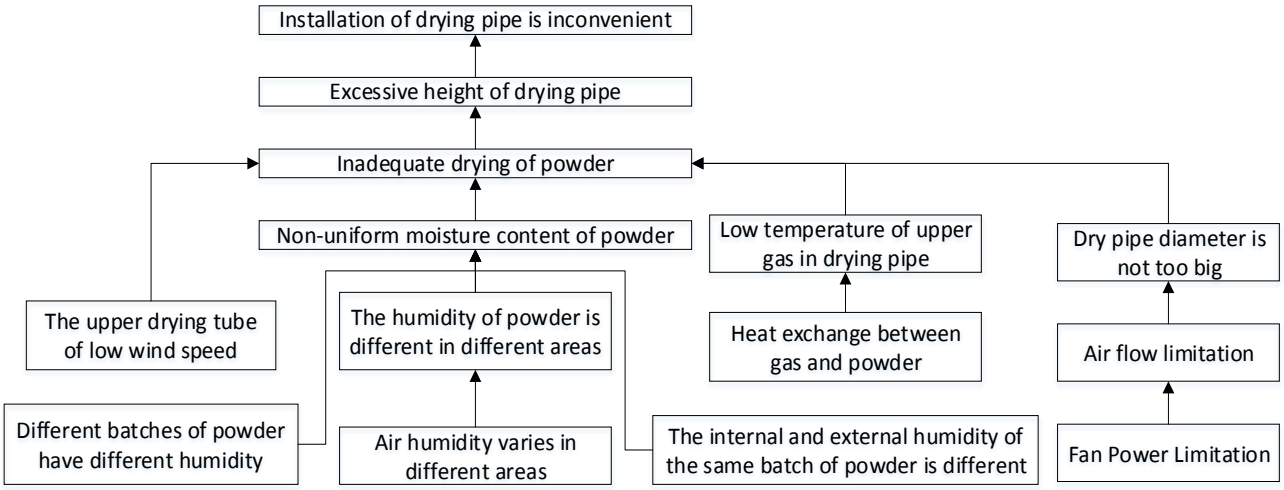


Figure 4 Cause-root chain

2.3 Conflict area

1) The height of dryer is high, the drying effect is good; Conversely, the manufacture is convenient.

2) The height of the dryer is fixed, the structure is simple. Conversely, The drying demand can be achieved.

3) Increasing the diameter of the dryer can reduce the height, but it needs to use high-power blower.

2.4 Available resource analysis

Table 1 Analysis of system direct available resources

Substance	Field	Time	Area	Information
Hot air	Fluid field	Feeding time	Dryer internal space	Before drying powder humidity
Dryer	Thermal field	Drying time	Dryer external space	After drying powder humidity
Cyclone separator	Field of gravity	Gas and solid separation time		Temperature of Hot Air
Materiel		Blanking time		

3 Problem solving

3.1 Ideal final result

(1) The ultimate goal: the height of air dryer is reduced, and the drying quality is guaranteed.

(2) The obstacle: the uniform humidity; the small diameter; low upper temperature; lowe upper wind speed.

(3) Result: the height of dryer can only be increased.

(4) Conditions for avoiding obstacles: The powder is dried at the lower position of the dryer.

(5) Available resources: preheating; high-power fan; conical tube structure;

Programme 1:Heating powder before drying, so it can maintain a higher temperature at high position of tube.

Programme 2:Increase the diameter of the dryer, or increase the power of the fan.

Programme 3:Make the dryer into a conical tube. The upper gas pressure of the dryer is low, reduce the upper diameter, so the upper pressure and wind speed is consistent with the lower. See figure 5 specifically.

1. Air filter;
2. Preheater;
3. Spiral feeder;
4. Feeding hopper;
5. Drying pipe;
6. Outlet outlet;
7. Air lock;
8.Cyclone separator;
9. Induced draft fan

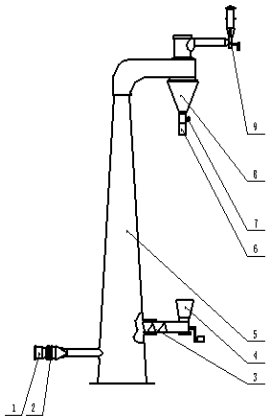
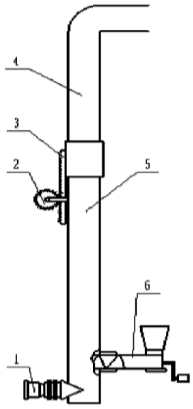


Figure 5 Conical dryer



1. Preheater;
2. Gear;
3. Rack;
4. Upper section of drying pipe;
5. Lower section of drying pipe;
6. Spiral feeder

Figure 6 Scalable dryer

3.2 Physical contradiction analysis

(1) Start with the key point of "uneven moisture of powder in different batches"

1) Contradiction description: Higher dryer can ensure the drying effect, But manufacture difficulties.

2) Separation principle: Different batches powder will be separated, so time separation principle is adopted.

3) Time separation principles include: No.9, 10, 11, 15, 16, 18, 19, 20, 21, 29, 34, 37.

4) According to the selected principles of invention, the following solutions are obtained:

Programme 4: According to No.15: Dynamization, gear and rack drive is used to control the tube height. The drying time of powder with different humidity is different, so the height is different. See Figure 6 specifically.

3.3 Engineering contradiction analysis

(1) Start with the key point of "low temperature of upper gas in dryer".

①Contradiction description: Heat exchange results in low temperature of gases at high altitudes. If only in the lower work requires repeated many times that reduced work efficiency.

②Standard description: Improved parameter:4. Static object length; Deteriorated parameter:39 productivity

③Contradiction matrix get invention principles:No.7, 14, 26, 30.

④According to the selected principles of invention, the following solutions are obtained:

Programme 5: According to No. 7: Sleeve: Designing the dryer into double-layer tube, Height can reduce. The collision between diverse direction airflow causes the airflow collides with the pipe wall.

Programme 6: According to No.7: Sleeve, the dryer is designed as a double-layer tube, as shown in figure 8. The powder is continuously circulated between the inner and outer tubes. Hot air takes out the vaporized water.

1. Feeding pipe;
2. Inlet port;
3. Outlet port;
4. Inner drying pipe;
5. Outer drying pipe.

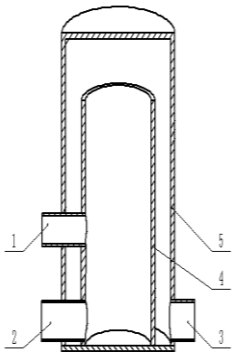
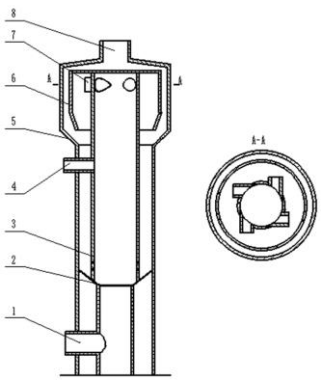


Figure 7 Double-tube dryer



1. Hot nitrogen inlet;
2. Screen mesh;
3. Air flow tank;
4. Intake port;
5. Return tank;
6. Return tank;
7. Cyclone outlet trachea;
8. Return Trachea.

Figure 8 Powder circulating dryer

(2) Starting with the key point of "the same batch of powder with different internal and external humidity"

① Contradiction description: In order to ensure the drying requirement of high humidity powder, it is necessary to increase the drying time. However, The same drying process at low humidity will wastes energy.

② Standard description: Improved parameters: 27 reliability; Deteriorated parameter: 22 energy loss

③ Contradiction matrix get invention principles:No.10, 11, 35.

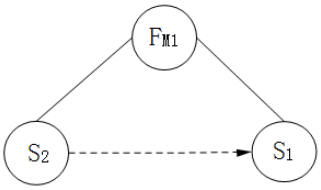
④ According to the selected principles of invention, the following solutions are obtained:

Programme 7: According to No.10: Pre-operation; Before powder drying, mix it evenly with a mixer to determine the shortest drying time to save energy. But adding a mixer complicates the structure.

3.4 Su-field analysis

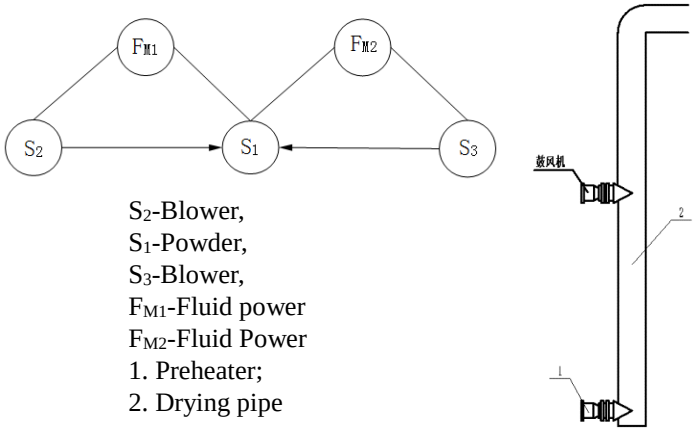
3.4.1 Start with the key point of "low wind speed in upper layer of dryer"

(1) Establish the su-field model of the problem, as shown in figure 9.



S_2-blower,
S_1-powder,
F_{M1}-fluid power

Figure 9 Su-field model with problems



S_2-Blower,
S_1-Powder,
S_3-Blower,
F_{M1}-Fluid power
F_{M2}-Fluid Power
1. Preheater;
2. Drying pipe

Figure 10 Improved su-field model

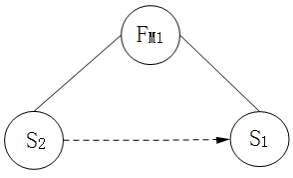
(2)The second kind of standard solution is applied: No.2.1.2 standard solution of the system is improved by changing the material-field model describing the system greatly.

(3) According to the selected standard solution, the solution to the problem is obtained.

Programme 8: According to No.2.1.2 standard solution, install blower S3 in the middle part of the tubeline, blow powder together with blower S2, so that, It can increase the wind speed of the upper part of the dryer.

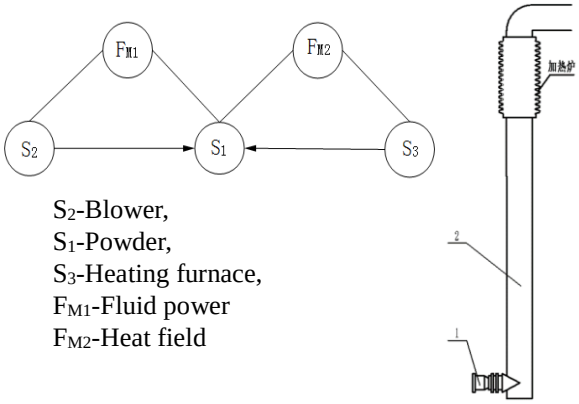
3.4.2 Start with the key point of "low temperature of upper gas in dryer"

(1) Establish a su-field model with problems, as shown in figure 11



S_2-blower,
S_1-powder,
F_{M1}-fluid power

Figure 11 Su-field model with problems



S_2-Blower,
S_1-Powder,
S_3-Heating furnace,
F_{M1}-Fluid power
F_{M2}-Heat field

Fig. 12 Improved su-field model

(2)Aiming at hot air drying powder model, the second kind of standard solution is applied: No.2.1.2 standard solution of the system is improved by changing the material-field model describing the system greatly.

(3) According to the selected standard solution, the solution to the problem is obtained.

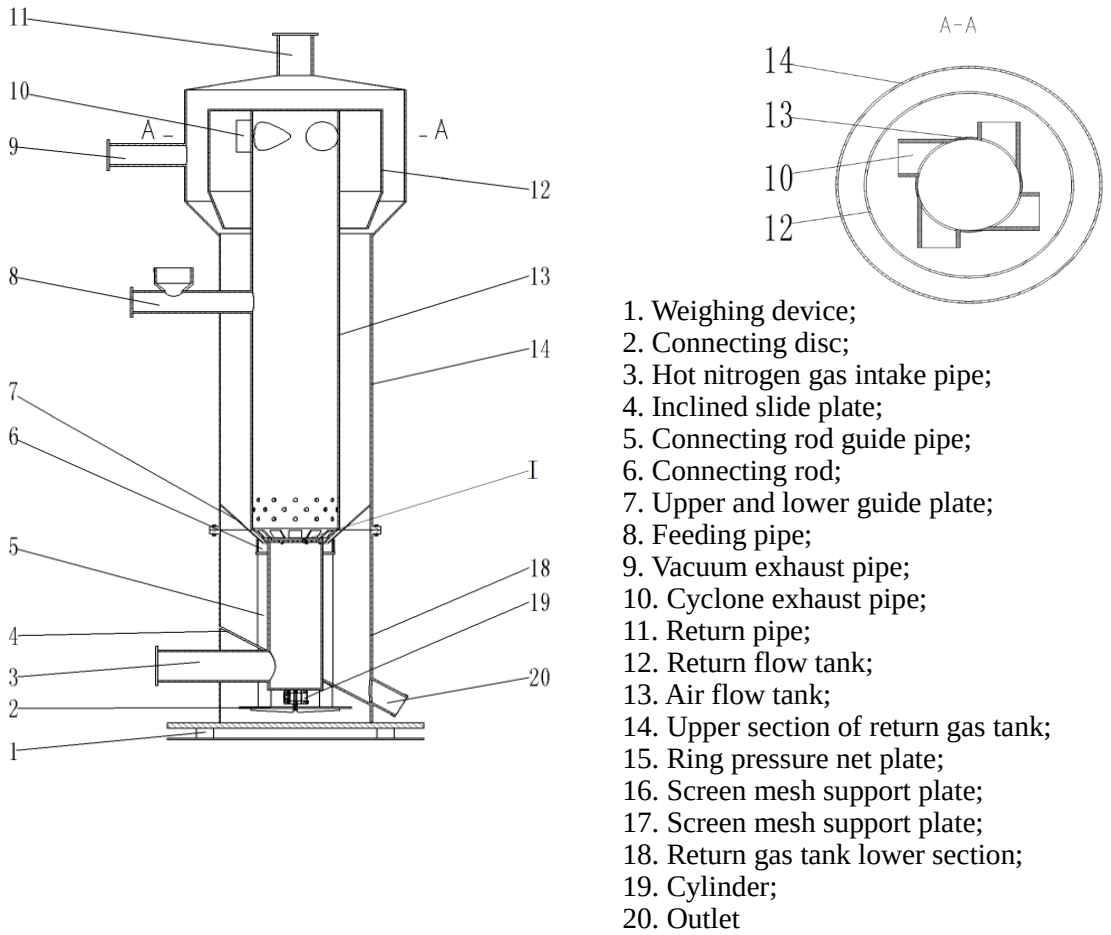
Programme 9: According to the standard solution No.2.1.2, a heater S3 is installed outside the upper end of the tube to assist heating the powder, It can improve the defect of insufficient heat at the upper end.

4 Programme evaluation

Table 2 Summary of programmes

	Programme	Tool	Availability evaluation
1	Heating powder before drying	Final Ideal Solution	Available, but increases costs
2	Increasing Dryer Diameter	Final Ideal Solution	Available, but low energy utilization
3	Conical dryer	Final Ideal Solution	Available, but difficult to make
4	Shrinkable dryer	15 Dynamics Principle	Available, but complex in structure
5	Double deck dryer	7 Sleeves	Available,
6	Circulating dryer	7 Sleeves	Available,
7	Mixing powder before drying	10 Pre operation	Available, but increased costs
8	Adding Blower	Standard Solution	Available, but low energy utilization
9	Adding Heating Furnace	Standard Solution	Available, but with a high risk factor

By combining the advantages of the above schemes, the final solution is obtained:



1. Weighing device;
2. Connecting disc;
3. Hot nitrogen gas intake pipe;
4. Inclined slide plate;
5. Connecting rod guide pipe;
6. Connecting rod;
7. Upper and lower guide plate;
8. Feeding pipe;
9. Vacuum exhaust pipe;
10. Cyclone exhaust pipe;
11. Return pipe;
12. Return flow tank;
13. Air flow tank;
14. Upper section of return gas tank;
15. Ring pressure net plate;
16. Screen mesh support plate;
17. Screen mesh support plate;
18. Return gas tank lower section;
19. Cylinder;
20. Outlet

Figure 13 Two-dimensional chart of short tube air dryer with optimal solution for powder circulation

Project ID: 7
Project Title: Microwave Weeding System
Team member(s): Darrell Mann, Kobus Cilliers, Shreyas Bakshi, Parag Raut
Organization/Dept: Systematic Innovation Ltd

Project Briefing

I. Motivation and objectives

The agriculture world currently spends over $120B per year removing weeds. Weeding work has always been an enormous frustration for farmers. Removal of weeds by mechanical means is extremely time-consuming and places severe mechanical challenges on the design of rotavators and other weeding removing systems. Chemical herbicides have become a dominant solution in recent years as a means of reducing the time and effort. The current herbicide market is worth close to $9B per year, with glyphosate being the most popular solution. More recently, there has been growing public concern that glyphosate is not only harmful to other plant-life but is also a carcinogen. Consequently, the whole agriculture industry is looking for alternative weed removal solutions that:
a) Require minimal effort on the part of farmers
b) Do not suffer from any of the collateral damage downsides that come with chemical weed killing solutions
c) Are low cost, both in terms of purchase cost and also ongoing running cost
d) Should be complementary with no-tillage farming solutions (i.e. it is now a well known fact that ploughing of soil does considerable damage, and so farmers are increasingly looking for solutions that do not require ploughing – this motivation essentially, however, makes the weed growth solution considerably more acute)
e) Are easily scalable – so suitable for large and small farms
f) Should not require any connection or power requirements that would demand changes to existing local infrastructure (datum case: remote farm in India)
g) Should also, ideally, help to nurture the soil and promote the cultivation of synergistic nutrients, bacteria and worms.

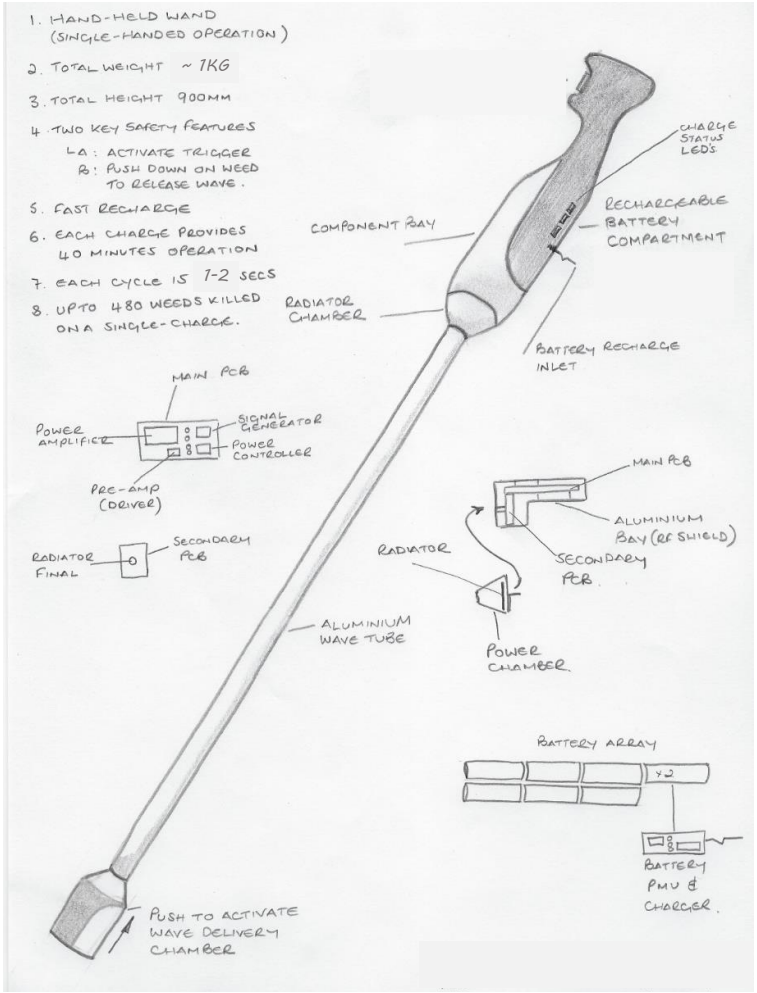
II. Features of the project

The solution to the problem makes use of a pulsed, point-focused microwave solution to locally heat the critical parts of a weed plant sufficient to trigger death of the weed. A molecular-level analysis of plant-life tells us that it is merely necessary to heat the base of the main stem of the plant to around 60-65degC in order to trigger death. Our solution, therefore, focuses microwave energy to achieve this. The evolution of the use of microwave energy began around 1910, and until recently the dominant means of generating microwaves has been the cavity magnetron. Recently, however, a new class of microwave generators has been made possible using solid-state technology. This new technology offers significant benefits over the cavity magnetron in terms of reduced size, reduced cost, increased life-time efficiency, increased durability and, specifically relevant to the needs of our solution, precision focusing.

Our first prototype solution comprises a hand-held ‘wand’ such that it can be held by a person in the manner of a walking pole (i.e. around 0.9m overall length) and pointed towards the ground. The distal end of the wand

comprises a wave-guide that focuses microwave energy to a point 4-8mm beyond the tip, such that when the person holding the wand positions the tip over the top of a weed plant and triggers the microwave, a short burst
of energy is focused onto the relevant part of the weed to be killed. Experience with the first prototype suggests that a 1-2second burst from a 300W microwave generator is sufficient to trigger death of the weed. So, in a domestic 'garden' application of the wand, the gardener essentially has to just walk around their garden, pointing the wand at any weeds found and pressing an 'on' switch to trigger the production of the microwaves that will kill the weed. The first prototype has also been fitted with a low-cost laser 'pointer' to assist the gardener to achieve accurate targeting. Because pointing a focused microwave at targets other than weeds (eg another human) could cause burns, we have also fitted a simple sensor device that, a) only allows the microwave to be triggered if the wand is pointed downwards and b) is positioned just above ground level.

Meanwhile, because the microwave wand is able to do its job with a 300W generator and requires very short pulses of energy, it is able to be battery-powered. On the first prototype, we have used six rechargeable Lithium-ion batteries, which has found to be sufficient for around 40 minutes of energy generation, which in turn we believe will allow a gardener to walk around the biggest kind of garden.



aving successfully demonstrated the domestic 'wand' version of the microwave weeder, the

next evolution stage is a bigger trailer or tractor mounted version, fitted with multiple microwave generators that will focus microwave energy as a pulsed 'strip' suitable for commercial farmers to weed large fields. Our primary focus here will be organic farmers that don't wish to use chemicals on their land and are very likely also to be using no-tillage farming methods to protect the integrity and nutrients found in healthy soils. Because the microwave energy is focused at weed-stem base height (i.e. 1-2 mm above soil level), we avoid collateral damage of the soil, and, as we kill the weed in situ, there is no need to remove the (now dead) root system from the ground, but rather allow it to rot and become the next round of nutrients required to encourage healthy growth of crops.

The ultimate evolution stage, made possible thanks to the extreme weight and size reductions achieved using the solid-state microwave generators means it is feasible to mount a generator onto an autonomous drone and to then effectively allow the drone to fly over a nominated plot of land and conduct weed control without the intervention of a human operator. One of the parallel – already proven by a partner organisation in India – technologies that enable this autonomous drone solution to work and to work efficiently is a visible weed recognition camera. The idea here being that the drone patrols over the field with the camera scanning for weeds. When a weed is detected, the drone positions itself such that the microwave wave-guide tip is positioned over the critical part of the weed and a 1-2second pulse of energy is released to kill the weed.

III. Value and Contributions

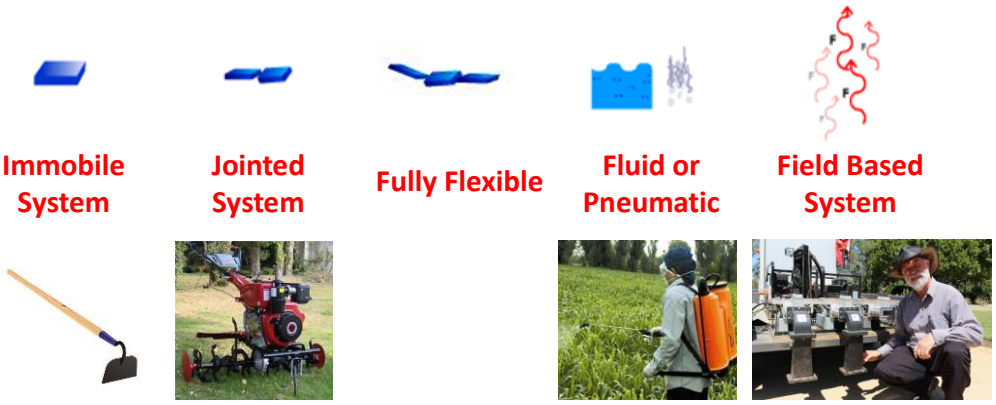
In its mature agricultural form, we expect the microwave weeding system to make inroads into the chemical weedicide industry very quickly. Farmers in many European countries have already converted to or are on their way to achieving 'organic' status and would love to eliminate the use of all chemical weedicides. This means that the $9B herbicide industry is our primary commercial agriculture target. The eventual elimination of all chemical herbicides would present an enormous global health benefit. We know, too, that there are considerable additional health and agricultural production efficiency benefits to be accrued from no-tillage farming solutions. The main thing preventing the widespread adoption of such no-tillage solutions is the problem of weeds. The microwave weeding solution offers farmers hoping to travel along the no-tillage route the perfect way to weed their fields without any physical contact with the soil.

Above and beyond the health and soil-protection benefits of our solution, we also recognize that increasing rates of urbanization, especially in Asia, mean that fewer and fewer people want to work in the agriculture sector. Agriculture has traditionally been a low margin, low-wage industry and so attracting workers to farms becomes a bigger and bigger challenge. One that necessitates the use of much more automated systems, and especially ones that are able to operate autonomously. One of the key things preventing automation of traditional mechanical field-preparation machines (rotavators, etc) is that it is very difficult to achieve high enough reliability when the ground being worked contains so many variables. A stray rock can easily jam and cause a rotavator to fail, thus requiring human intervention. Because our solution replaces the mechanical with a 'field' based solution – per the TRIZ evolution trend – it becomes much easier to design a highly durable solution because the device need never come into physical contact with the ground. The Indian market for mechanical rotavators is typically worth around $200M per annum. We would imagine that our mature solution will be able to disrupt a significant proportion of this market.

Meanwhile, one of the biggest challenges for any disruptive innovation is the need to find a high-value niche early adopter who can afford to pay a premium for the solution before the longer-term economies of scale are achieved. The perfect opening for us here, according to initial market research we've conducted, is the domestic gardener, probably in the US and Western European markets. The weeding solutions available to these customers require either hard manual labour, the use of potentially carcinogenic weedicides or dangerous naked-flame based weeding devices. The microwave 'wand' solution, which we have in effect already demonstrated with our first prototype, makes for a step-change win-win solution to customers of these types of product. Weeding the garden now becomes as simple as walking around the garden pointing the wand at the weeds that require to be eliminated. Initial market research in the UK suggests that we could be looking at a $10M per annum revenue stream for just this domestic gardener customer type.

IV. The ideas generation process

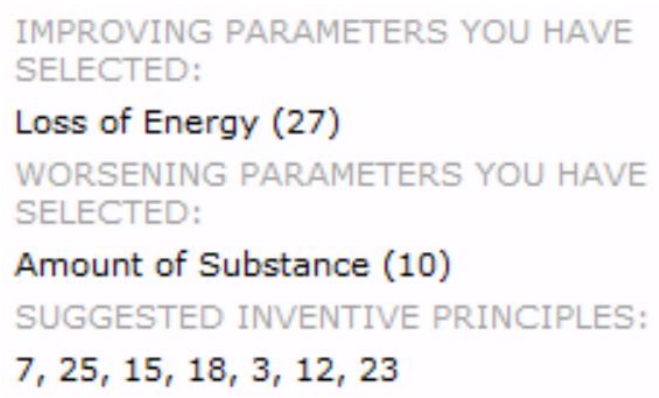
The first step with any of our projects involves analyzing the evolutionary maturity of the available solution technologies. One of the critical Trends of Evolution concerns increasing dynamization of systems. When we plotted the weeding evolution story, we could quickly see that the first 'field' based systems had begun to appear:



This finding immediately then told us that our solution needed to focus on the righthand side of the trend and also needed to involve a 'field'. Use of the patentinspiration software revealed that microwave was the

preferred solution. Essentially because the frequencies involved were compatible with the known resonant frequency of water, and as such well-matched to the chemistry of the weeds that we are trying to eliminate. The importance of making use of resonance is commensurate with another important Trend: Rhythm Coordination. The big advantage of resonance being that it acts as a potent means of reducing the power consumption of systems. That said, when we identified the leading microwave weeding solution from the global patent database (WO2018112531) and we held a telephone conversation with the inventors we were surprised to learn that their solution consumed 9KW of energy and needed to be tractor-mounted. Clearly this was not going to be acceptable in our situation. We learned from the inventors that they were essentially using the energy to 'cook' the soil to a depth of up to 2ft in order to ensure they killed the root-stock of the weeds. After talking to biologists, we learned that it was not necessary to 'burn' the whole weed in order to kill it. Judicious focusing of the microwave energy onto a small part of the stem of the weed to locally heat to 60-65degC would be sufficient. So the immediate challenge was to see if it was possible to precisely focus the microwaves onto a small area. Another patent search revealed a new

generation of solid-state microwave generator that allowed the sort of focus we needed (this new generation generator also, very conveniently, allowed us to design around the WO2018112531 patent). The microwave focus solution allowed a significant reduction in power consumption, but we decided that our ideal – given the potential difficulty of getting electrical power to locations where mains electricity was not a given – was to reduce power consumption to the point where we could consider the use of battery power. It was time to work on the next contradiction. Which we formulated as our desire to reduce power loss being prevented by the amount of weed material we were potentially required to heat on a single charge. Here's how we mapped this on to the latest Contradiction Matrix:



The Inventive Principle suggestions gave us a number of ideas that we have been able to build into our design and the subsequent prototype. Namely:

1) Pulsing the microwaves (Principle 18)
2) Finding a way to identify and distinguish the weeds from surrounding useful crop materials (Principle 25)
3) Incorporation of a cheap low-cost laser light to serve as a targeting means (Principle 23)

So, in summary, our overall ideation process followed the sequence: use Trends to identify which basic technology to use; use the Knowledge-search part of TRIZ to identify candidate technology solutions and to better understand the biology of the weed; identify the next important contradiction and use the Contradiction-solving tool of TRIZ to resolve the contradiction and make several further jumps towards the eventual ideal solution.

Project ID: 8
Project Title: MyDietDay: An Alternative Solution to Obesity, Overweight, and Maternal Based Websites to Improve Healthy and Effective Diet
Team member(s): Indri Hafida, Linda Arum Sari, Mohammad Afan Setyadi, Muhammad Zaini Rahman, Alfredo Juan Pratama
Organization/Dept: University of Brawijaya

Project Briefing

I. Motivation and objectives

Overweight and obesity is a body that has excess body weight with body mass index 25 - 29.99 and > 30. According to WHO, in 2016 over 78% woman and men around the world over the age of 17 were overweight. This is because overweight and obesity are not only about body weight, but also indicates a high risk of degenerative disease such as heart disease, dyslipdemia, diabetes, hypertension, cancer, until stroke. Both of these nutritional problems can occur in all ages, including pregnant and lactating women.

According to WHO, in 2010 over 14.9% 0-6 months infants had poor nutrition. The mother's diet and infant malnutrition take the biggest responsibility for poor nutrition in infants. Increase in body weight of a pregnant women is one indicator of fetal development and also important for the preparation process for breastfeeding. Setting the right diet program for pregnant women can support physical health, fetal mental development, and reduce pregnancy complications such as gestational diabetes, preeclampsia, and eclampsia. Therefore we created the Mydietday, a website that can be easily accessible to helps improve healthy living.

II. Features of the project

Mydietday is a diet application that can be easily accessed via smartphone. Mydietday designed generally to calculate energy requirements, nutritional status, ideal body weight, advise on proper physical activity and arrange menus to reduce, increase, maintain, or to control body weight and nutrition of pregnant and lactating women. Another feature is storing and re-accessing a history of diet programs that have been made before and consult with registered dietitians and midwives via live chat. In addition, this application also develops as a business plan where customers can order food according to their own menu prepared at the catering provided.

III. Value and Contributions

Mydietday's goal is to make the third sustainable development goals "Good health & wellbeing" successful by helping to develop a diet program to reduce the prevalence of diseases worldwide. Therefore we created the Mydietday, a website that can be easily accessible to helps improve healthy living. Expected results are the prevalence of the problem of weight loss decreases and the culture of healthy lifestyle increases so that it can reduce the mortality rate due to degenerative diseases.

IV. The ideas generation process

Our steps for ideas generation:

1. We find some problems that need to be solved
2. After that we make a hypothesis
3. Make a research design
4. Sketch a low fidelity prototyoe
5. Make an application prototype

Project ID: 9
Project Title: Loborats (Lombok Boat Rapid Transit System) Integrated Tourism Crossover Services as an Innovation to Easily Access of Passenger Movements
Team member(s): Olga Putri Sholicha, Refiantika Rachma Utami, Rudi Haryanto, M. Bayuni Ilham
Organization/Dept: Institut Teknologi Sepuluh Nopember

Project Briefing

I. Motivation and objectives

1. Background:

Lombok Island is one of tourism destination which is often visited by domistic and also international tourist, The potention that Lombok Island had like its natural beauty, its beautifull beaches and the view of sunset and sunrise, the culture, and also the tradition of its people is fascinating for tourist to come to Lombok Island. But, it's not supported by a proper mode of transportation or services which facilitate the tourist to come or explore Lombok Island itself. There are currently two kinds of boat that can be optioned to cross gili- gili around Lombok Island, it was public boat and speed boat. Public boat is a traditional fishing boat transformed to carry the tourist who wants to cross over from Lombok Island and gili-gili around it. According to the result from a survey of some domestic and foreign tourist, few of them said that the service at the port is not well coordinated because of its procedure or its horrible system. Public boat will only depart of it's already full and the porter will raise the goods onto the boad so that the torist should wait the porter to load the goods and it's hard for the tourist as the passenger to step on the boat because there will be too many items, trouris's feet will be wet and sandy because there is no harbour, it's such uncomfortable condition for the tourist. But at the end, they will still choose the public boat because of it's cheapest rate which only cost Rp.14.000 until Rp.20.000 per person. The following picture is an overview of the Public Boat in Lombok Island

Gambar 1. Condition of the traditional fishing boat transformed to a public boat
Sumber : www.marijelajahindonesiaku.com (2018)

Fast boat is one of the option that frequently used by the tourist because of it's expensive rate which cost Rp.85.000 to Rp.150.000 per person. With the faster travel time, and the tourist dont need to be wet and sandy because the boat is already wait in the harbour. However, to go with this boat, The tourist need to rent the ship for five to six people for one way only and it cost from Rp.200.000 to Rp.250.000 but they can depart without waiting for the boat to be full of passenger like the public boat system. The following picture is an overview of the Fast Boat in Lombok Island

Gambar 2. One of the transportation to cross Lombok Island which quite expensive
Sumber : www.marijelajahindonesiaku.com (2018)

By having two options of boat is very inefficient according to increasing number of the domestic and foreign tourist who visited Lombok Island and the island around it. There are still many things that could troubled the tourist to move from one destination to another destination beacause there are no proper decent boat operating with routes that reach all of the destination places. The other problem is, the incidence of significant price differences between the boat due to lack of standarization of prices that that caused inconvenience to visitors. For the traditional boat are often had over capacity because there is no effective scheduling in carriege of passengers. Futhermore, the absence of dock facilities forced the tourist to get wet when they climb and go down from the boat.

2. Motivation:

Tourism is one of the source of income is a reliable area. Lombok Island is already famous among both the domestic and foreigner tourist, which most of its tourism place were nautical tourism. Lombok Island is surrounded by many small island such as Gili Air, Gili Meno, Gili Trawangan, and others. The Service system to cross between gili and Lombok Island currently use traditional fishing boat that still far from decent words. Actually, fishing boat are designed to carry fishes, but the locals use it to carry the tourist who want to cross from Lombok Island to gili. In terms of every safety system the boat is definitely does not eligible for passenger ship. In addition to the fact that occur in the field are still plentiful ticket scaipers which give the harmful effect to the tourist and not integrated schedule system. From the facilities side there is also a lot of supporting aspects which is not eligible such as the lack of dock that forced the tourist to get wet in their way to get in and get off from the boat. That is why we offer the service system with intgrated ship crossing designed specifically for passengers based on Mass Rapid Transit (MRT) on water transportation facilities equipped with supporting facilities such as Floating Jetty Dock, the application to book the ticket (seat ticketing) and integrated scheduling. The system named Lombok Boat Rapid Transit (LOBORATS). Thus the system can facilitate the transfers of passengers from Lombok Island to the small islands around it and improve the quality of tourism in Lombok Island.

3. Objective of the Project :

a) Current condition of crossings system between Islands of Lombok

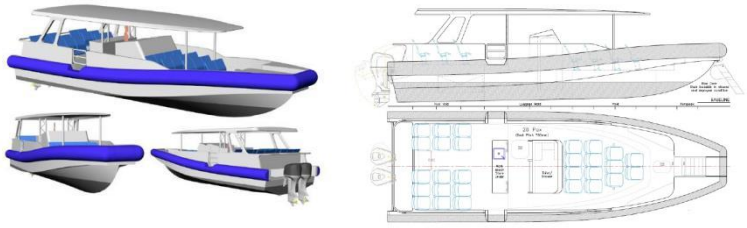
b) Know the operational system of LOBORATS.

c) Calculate the cost needed for the procurement LABORATS system and profit which would be obtaioned from the system.

II. Features of the project

LOBORATS is a crossing route tourism model to support integrated crossing service system. In the system thre are 3 basic components that are synergize, those components are passenger ship fleet that specially designed to load passengers/ tourist complete with lifebuoy and other safety tools. LABORATS ship has a capacity of 30 people with one seat for one person so no

more cheating such an overload capacity conducted by persons who are not responsible.



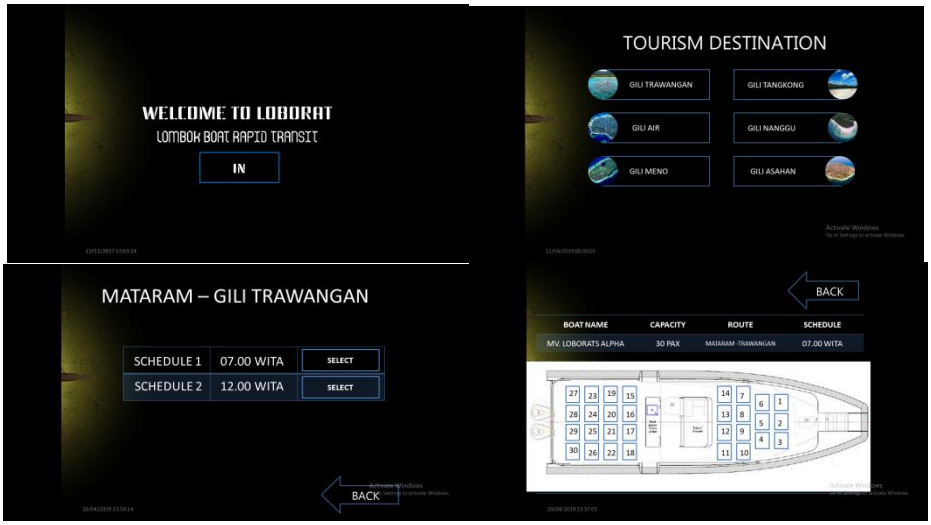
Gambar 3 The Design of the Boat

Second, is a floating pontoon dock designed fot the ship to lean and for passengers to walk from beach to the land. This floating pontoon dock will be placed 10 meters away to the sea from the beach with a width of two meters and it will be flexible because the pier will follow the ups and downs of sea water.

Gambar 4 The Boat Berthing Places

In addition, there are Wterway Station, which is the facility that used to make the booking related to seat ticketing system introduces in LOBORATS. This station is a small hall that are designed with local wisdom, and has the building area of 10 x 10 meters. There will be ticket booking machine which contained the application that already designed as indicated in the following, and for the payment will use E-Cash Ticketing card as follows.

Gambar 5 E –Cash Ticketing Design



Gambar 6 The Mockup of Aplication

III. Value and Contributions

We are creating an integrated modern system to facilitate passenger transfer access from Lombok Island to small islands around it with some useful support facilities for passenger safety and to avoid inequality prices, excess passengers (loads), and irregular vessel scheduling so hopefully can improve the quality of tourism in Lombok. The contributed will be offered the following:

a. Provide integrated crossing service system with crossing vessels designed specifically for passengers based on Mass Rapid Transit (MRT) to ensure the safety of passengers.
b. Provide new jobs for local people.
c. Inform the schedule of crossing ships from Mataram to tourit sites in gili so that the crossings can be regular schedule and travellers don't have to wait for a ship to full before depart.
d. Can do the seat ticketing process by ordering the empty seats on ship.
e. Provide automatic payment system namely *e-ticketing*.
f. Offers the cheaper price so there won't be inequality price.
g. Impose one seat for one person system
h. Can prevent the occurrence of overload or excess charge on ship while operating
i. LOBORATS system provide the floating dock in every water way station so the tourist don't need to be wet and dirty when they down form the ship.

IV. The ideas generation process

1. The research methodology is the stages in working on this problem. Then it will be presented with a flowchart in paperwork. The stages of research in this work are divided into several parts, including:

2. In the initial stage for making this system, identification of problems was carried out by analyzing the related transportation facilities in the tourist sites of Gili Islands, Lombok, West Nusa Tenggara.

Project ID: 11
Project Title: Innovative Product Development for Pressure Vessel
Team member(s): Mei-Hwa Chen, Hsin Rau
Organization/Dept: Chung Yuan Christian University

Project Briefing

I. Motivation and objectives

Pressure vessels are widely used in various industries such as petrochemical, steel, dyeing and finishing, and automobile. Poor structure or long-term storage reduces reliability which lead to cracks and explosions. Negligence on periodic checking of potential hazards may result in accidents such as gas leaks that endanger the operator as well as the surrounding environment. It is important to confirm the pressure level defined in the specification and whether it is suitable for the current design conditions of the pressure vessel. In addition to the pressure range, it is necessary to pay attention to the design temperature. Also, the pressure vessel identified by the specification, whether it contains connecting pipes, other container fittings, etc.

Design strategy is developed based on TRIZ and fuzzy QFD to address the reliability shortfall and safety issues. The purpose of this study is to develop a new product design methodology in two main phases: (a) establishment of fuzzy QFD and (b) evaluation and selection of prototype products. The resulting design does not only innovate pressure vessels but also serves as a design reference which promotes safety on pressure vessels from the known harsh environment.

II. Features of the project

The design criteria are further developed by using optimization which transformed into a linear programming (LP) problem. The subjective assessment is directly taken into account and the data envelopment analysis (DEA) model in context is constructed. Without using the CCR model or the BCC model, the grouped-QFDEA model is proposed for parameter ranking as the study included project management factors as evaluation factor.

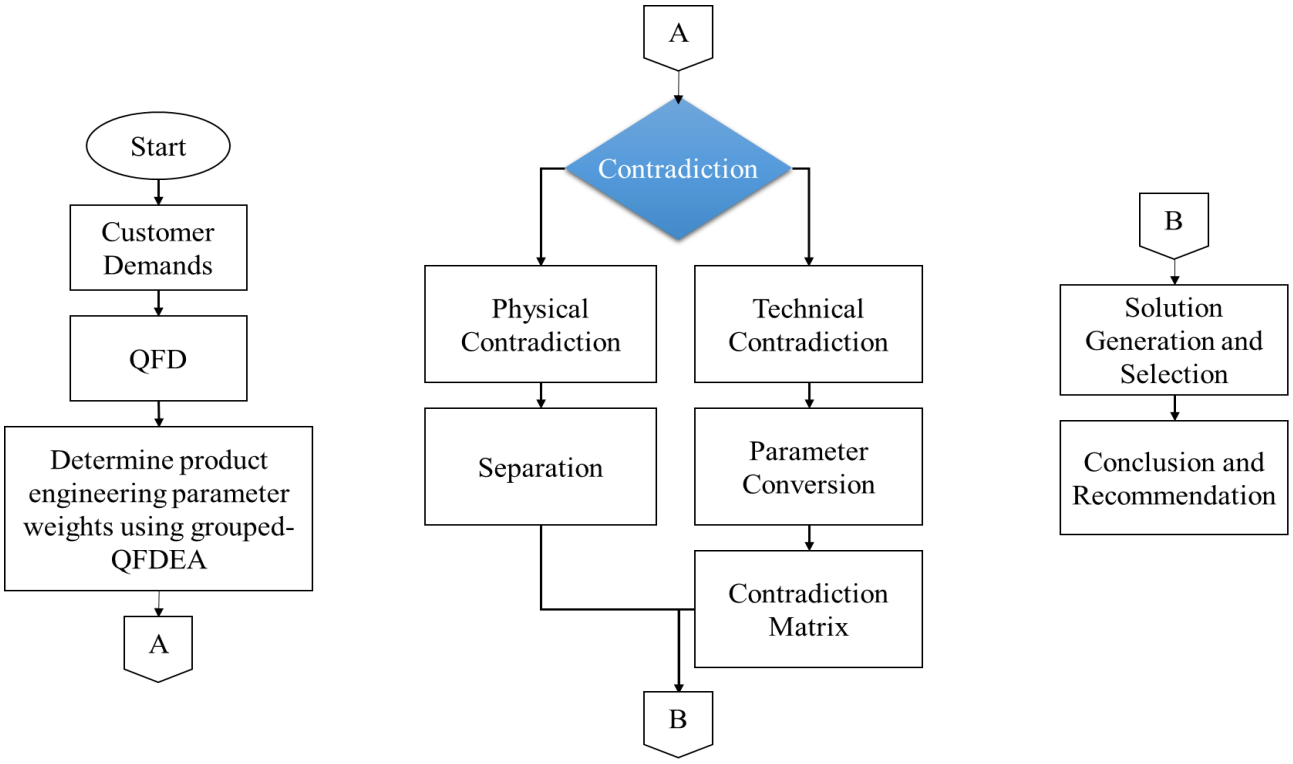
The products developed in this case have the advantages of low cost, light weight, and high

pressure resistance design for pressure vessels. However, there is still room for improvement and efforts in product process stability. The research process and method of this project can provide the industry with design reference in product innovation.

III. Value and Contributions

Optimization of customer requirements with respect to the design attributes addressed the pressure strength of the container as main priority. The use of linear programming to identify critical problem points provided a decision model prior to solution generation. The problem with material strength was directly addressed by the ranking results. The use of LP proved significant decision-making by filtering engineering parameters in contradiction. Needs are concentrated and more focused that solutions are more effective. Use of composite materials is proposed and produced major improvements to reliability. The composite material such as carbon fiber reinforced polymer (CFRP) is a new material with excellent mechanical properties for the container shell. Its rigidity/specific gravity, corrosion resistance, high temperature resistance, etc. improve base conditions. The strength of the shell made of carbon fiber composite material is increased by 3 times and the weight is reduced by 50% compared with the metal material casing. The resulting design solved the reliability risk of the container with the replacement of its initial material also improving its weight.

IV. The ideas generation process



Project ID: 12
Project Title: TRIZ++ Methods to solve white spots problems in wafer manufacturing processes
Team member(s): Hsuan-Yi Wu, D. Daniel Sheu, Jealousy Hong
Organization/Dept: Phoenix Silicon International Corp.

Project Briefing

I. Motivation and objectives

In this case, the semiconductor wafer processed by BM (Back Metal) and BM (Back Grind) processing technology and the wafer is thinning from 750um to 100um, and the wafer is coated according to customer requirements. At testing station, the product was judged to be defective due to the white spot problem, as Figure 1.

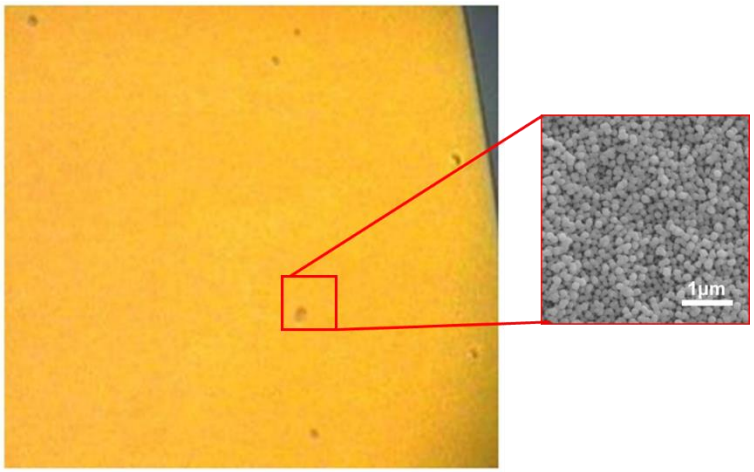


Figure 1. White spot defectives in wafer manufacturing processes

Thus, the main purpose of this project is to help improve the white spot defectives problems faced by the P company.

II. Features of the project

This research integrated TRIZ tools for problem solving. The process includes five steps: (1) Problem Definition; (2) Problem Analysis; (3) Solution Generations; (4) Solution Selection and Integration; and (5) Solution Verification. This structured process can help problem solvers convert murky surface problems to the failure points, and then to critical key disadvantage(s) effectively. TRIZ tools in this paper, including functional analysis (FA), cause-effect-contradiction chain analysis (CECCA), contradiction matrix (CM), inventive principle (IP), physical contradiction, parameter manipulation, device trimming, function-oriented search, etc.

III. Value and Contributions

After generating the solutions, we introduced Pugh matrix to evaluated the solutions and picked the most influential solution, which is "Extend the processing time of the vapor deposition to evaporate the residual acid". Then, we calculated the financial and non-financial value of the solution, as Table 1.

Table1. Financial Analysis of the final solution

	Benefit	Cost
Financial Analysis (per month, NTD)	Labor cost: 50,000	Electricity fee: 5,000
	12 Hrs. X 14 days= 168 Hrs.; NTD: 300/Hr. * 168= 50,400	25 machines; 10 batches per day Each lot cost 1.43 NTD per day 25*10*1.43*14
	Research cost: 50,000	Loss of revenue: 810,000
	Research cost: NTD: 5,000/Hr. Estimated to take ten hours	The original machine produces 11 batches per day. But now, the machine can only produces 10 batches. 15 pieces per batch; $30 per piece
	Compensation: 900,000	
	Compensation: USD200/piece Total:150 pieces	
	Loss of stopping line: 1,890,000	
	Losing cost before: USD: 30 / piece; The customer ships 150 pieces a day; 14 days in a month	
	Total Benefits: **NTD: 2,890,000**	Increasing cost: **NTD: 815,000**
Others	Improve customer trust in the company's technology and problem solving skills	NA
	Decrease order unfulfilled due to defectives	
	Reduce the cost of re-work due to defectives	

The solution generated by the project is estimated to bring in a monetary benefit of NT$ 2.89 million per month, and an additional cost of NT$ 305,000 per month. It can be seen that the

financial benefits are considerable. Besides, the solution can also bring some non-financial benefits, mainly including 3 benefits as follows: (1) Improve customer trust in the company's technology and problem-solving skills. (2) Decrease order unfulfilled due to defectives. (3) Reduce the cost of re-work due to defectives.

Overall, the contributions of this project include: (1) Integrating existing TRIZ process to help analyze a company's real-world murky, complex problems more effectively; (2) Applying parameter manipulation methods on the murky problem to greatly enhance the solution quantity and quality.

IV. The ideas generation process

The ideas generation processes are mainly follow the five steps: (1) Problem Definition; (2) Problem Analysis; (3) Solution Generations; (4) Solution Selection and Integration; and (5) Solution Verification. The flow chart is as follow Figure 2, the yellow-marked process was introduced in the project:

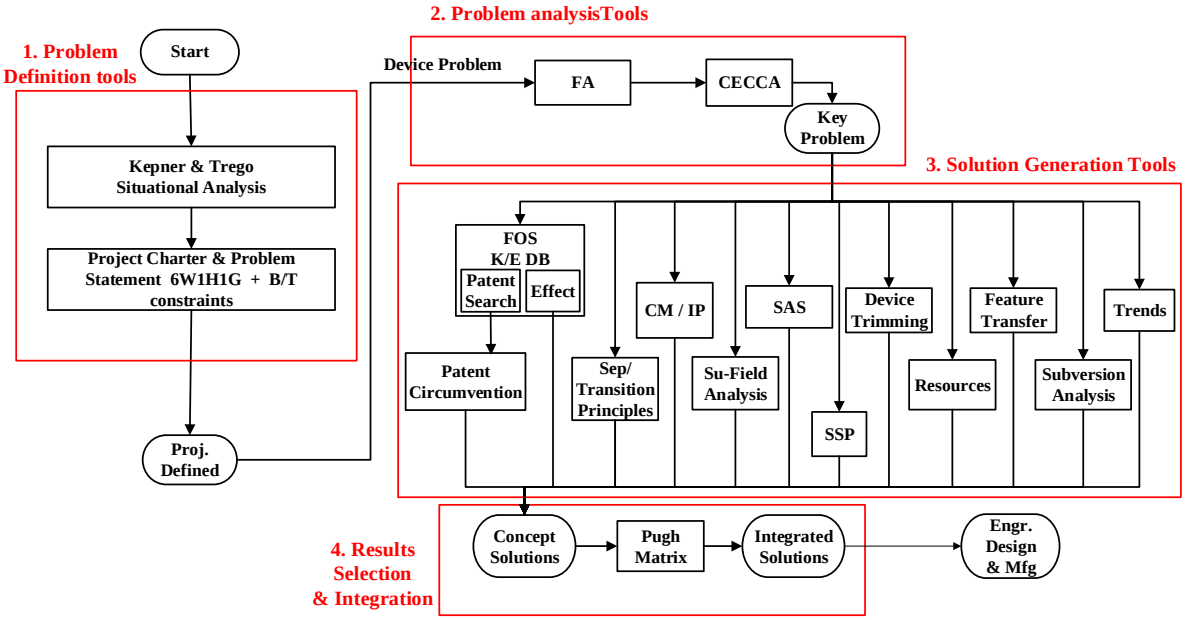


Figure 2. TRIZ^{++} problem analyzing & solving process.

1. Problem Definition

In this phase, we introduced problem statement chart to briefly described the problem with 6W1H1G method (What problem?, When was it happen?, Where is it found?, etc.) , physical figure of the problem occurs. Make sure the team can solve the "right problem", :significant problem".

2. Problem Analysis

The first step of problem analysis is to draw the functional analysis diagram, as Figure 3.The purpose of FA is to clearly indicate the relationship between components and where the system has problems.

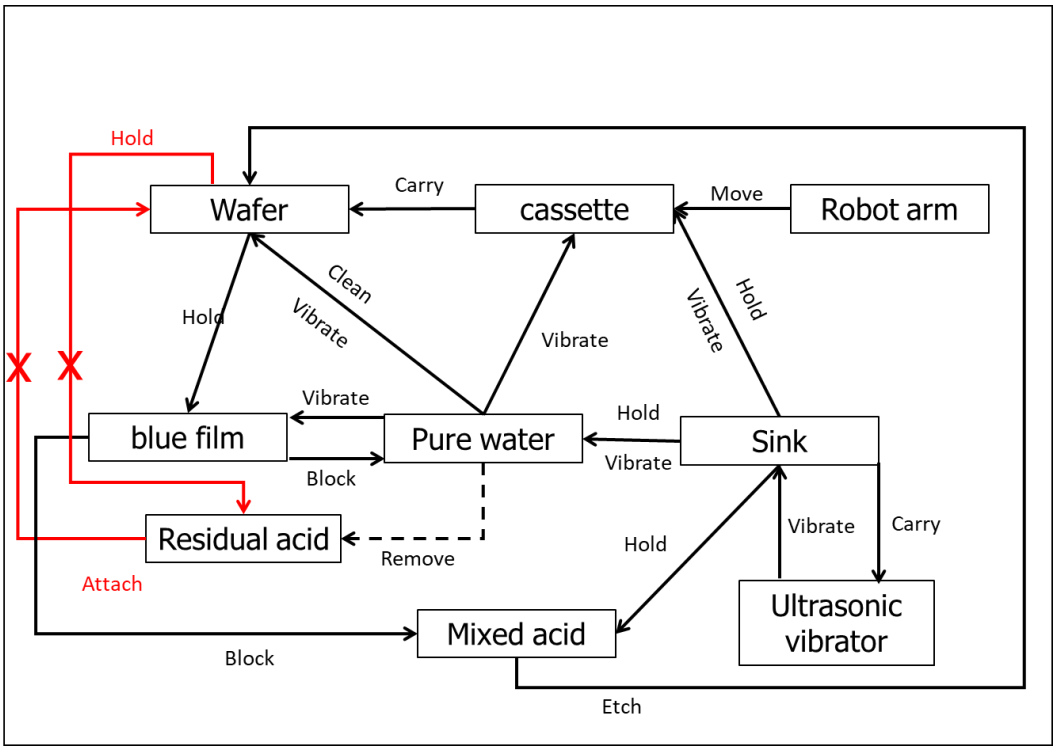


Figure 3. FA of the etching system

We picked the most significant disadvantage as target disadvantage, that is ,"Residual acid etched wafer". After defining the target advantage, we use Cause Effect Contradiction Chain Analysis (CECCA) to expand the target advantage, in order to find out the key problem of the system. The CECCA is as Figure4.

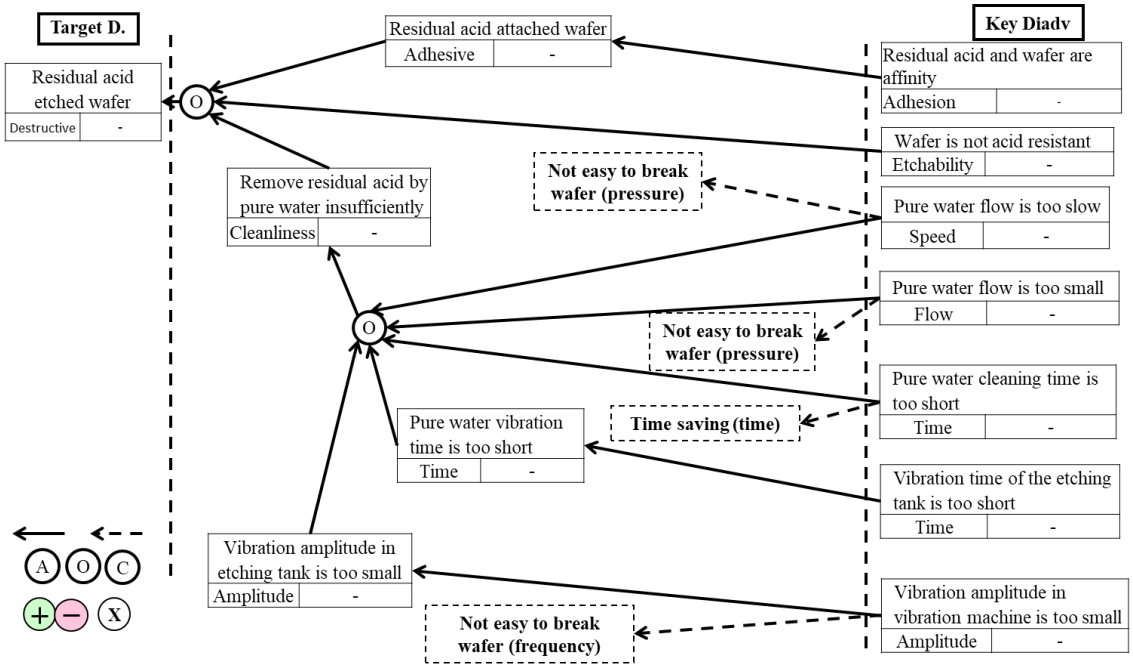


Figure 4. CECCA of the etching system

In CECCA's diagram, we can see that there are 7 key disadvantages in the system, including 4 contradictions. We used conflict family identification table to list the physical contradiction/improving factors/worsening factors as Table 2.

Table2. Conflict family identification table of the system

Priority	**[IF] Physical contradiction@(-)**	**[THEN] Improving factors (-→+)**	**[BUT] Worsening factors(+→-)**
1	Increase speed of water flow	Residual acid does not erode wafers Residual acid is washed away by water (23)[25]Loss of Substance (31)[31]System General Harmful Effects	Wafer is easy to be broken. (11)[19]Stress Pressure (23)[25]Loss of Substance
2	Increase amount of water flow		Consumption of water resources (23)[25]Loss of Substance
3	Increase washing time		Increase process time (25)[26]Loss of Time
4	Increase vibration amplitude		Wafer is easy to be broken. (11)[19]Stress Pressure (23)[25]Loss of Substance

3. Solutions generation

3.1 CM/IP

The 40 invention principles (IP) aimed at the point of conflict. It analyzes its improving factors and worsening factors. There are corresponding attributes in both aspects. Through looking up the contradiction matrix (CM), the principle of invention can be quickly obtained, the user can quickly pop up a concept solution conceived by this principle. A solution popped up with invention principle 18-Mechanical Vibration. "Shake the tank through the ultrasonic oscillator or shake it through the robot arm.", the concept diagram is as Figure 5.

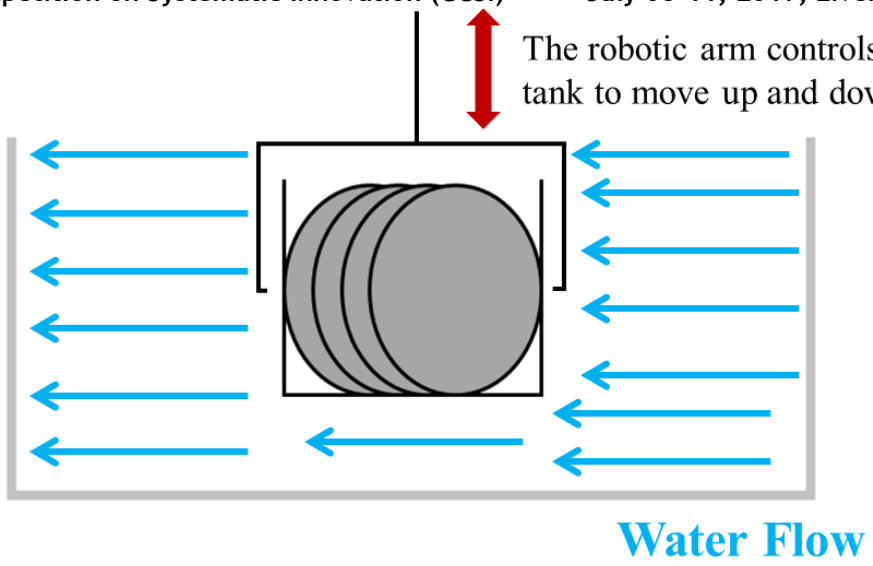


Figure 5. One of the solutions obtained by CM/IP

3.2 Functional-Oriented Search (FOS)

FOS is a function-oriented search that the original function between the components in the system is converted into a generic function, and search for knowledge bases such as patents and scientific effects. We have clearly defined the keywords as Table 3.

Table 3. Function-Oriented Search table

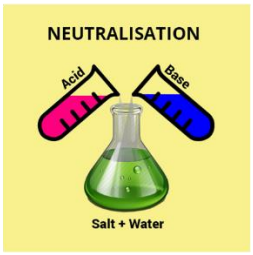
1. Key problem to be solved	Residual acid caused the substrate to be eroded
2. Specific key function	Remove residual acid
3. Required parameter/Attr. (value ranges)	1. Water flow strength does not damage the wafer. 2. Process temperature at normal temperature
4. Generalized function (Func/attr. key words;)	Expanded function: Remove liquid, neutralize acid Expanded Attributes:

Through this method, We generated several new solutions, two of them are as Table 4. Table 5.

Table 4. Solution-Centrifuge

Original Function	Prevent residual acid from eroding wafers	**Generic** Function	Remove Liquid
Effect(s)/ Resources	Centrifuge		
Specific Approach	The acid is removed by centrifugal force to achieve the goal avoiding white spot issue.	Diagram of specific idea.  DB Source:http://www.productioninspiration.com/	

Table 5. Solution-Centrifuge

Original Function	Prevent residual acid from eroding wafers	**Generic** Function	Remove Liquid
Effect(s)/ Resources	Coagulation		
Specific Approach	Adding alkaline ions to the water allows the residual acid to be neutralized with water to make the fluid non-aggressive to the wafer.	Diagram of specific idea.  DB Source:http://www.productioninspiration.com/	

3.3 Parameter manipulation

Based on the two conflicts obtained by CECCA, through the identification and definition of the center parameters of the problem, the appropriate parameter construction can be established. When necessary, the parameters can be decomposed into multiple layers and expanded. Then, concept solutions can be generated by parameter separation and parameter transfer. Table 6 is the result of parameter expansion.

Table 6. Parameter expansion

System：Etching Machine			+P	Big water flow /Vertical to the wafer	-P	Small water flow /Parallel to the wafer					
O_1	Washing residual acid		O2	Keep the wafer intact							
Center component / peripheral component											
Wafer			Residual acid			Pure water			Blue Flim		
Para.	O_1	O_2	Para.	O_1	O_2	Para.	O_1	O_2	Para.	O_1	O_2
Affinity	↓	×	Concentration	↓	×	Flow	↑	↓	Thickness	×	↑
Thickness	×	↑	Amount	↓	×	Cleanliness	↑	×			
Hardness	×	↑	Etchability	×	×	Direction	→.	→..			
Completion	×	↑	Adhesion	↓	×						
Para. expansion	[O_1] Washing residual acid=fn(Pure water flow ↑, Pure water's direction→.; Wafer's affinity↓, amount of residual acid↓, residual acid concentration ↓, residual acid adhesion↓, Cleanliness of pure water ↑,) [O_2] Keep the wafer intact=fn(Flow of pure water ↓, Pure water direction→..; Wafer Thickness ↑,Wafer hardness↑,Thickness of blue flim ↑) [P]Amount of pure water flow =fn(Pump power, water supply pipe size) [P] Pure water's direction=fn(Pump opening, water supply pipe line direction)										

For parameter manipulation tools we also generated several solutions and includes adding blades to the tank as Figure 6 and extending the processing time of the vapor deposition as Figure 7.

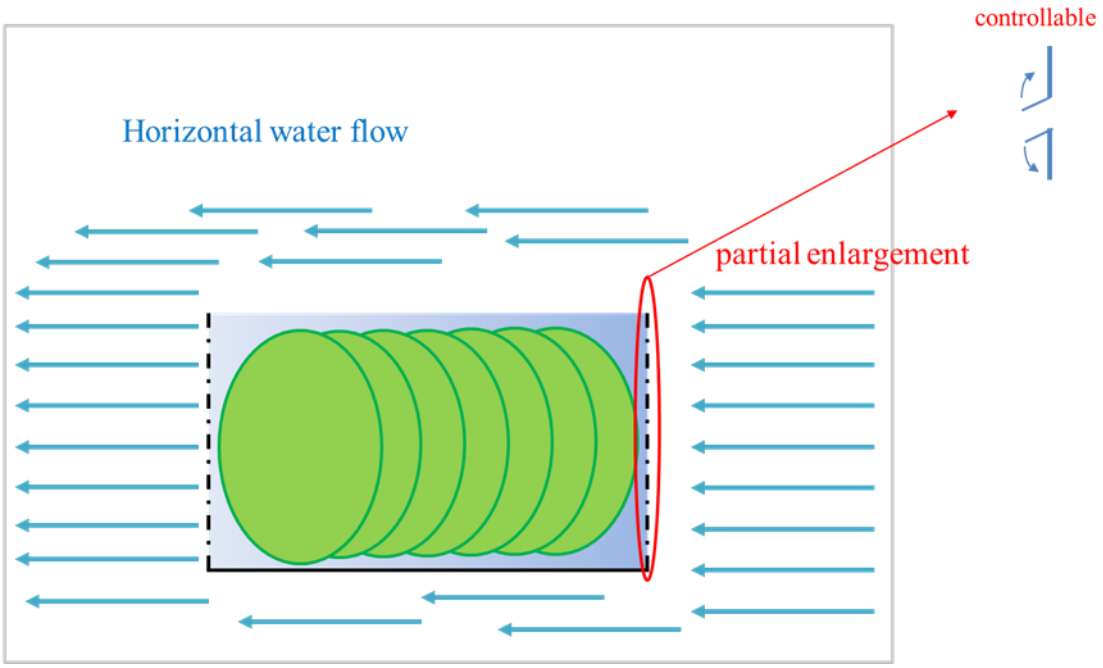


Figure 6. Adding blades to the tank

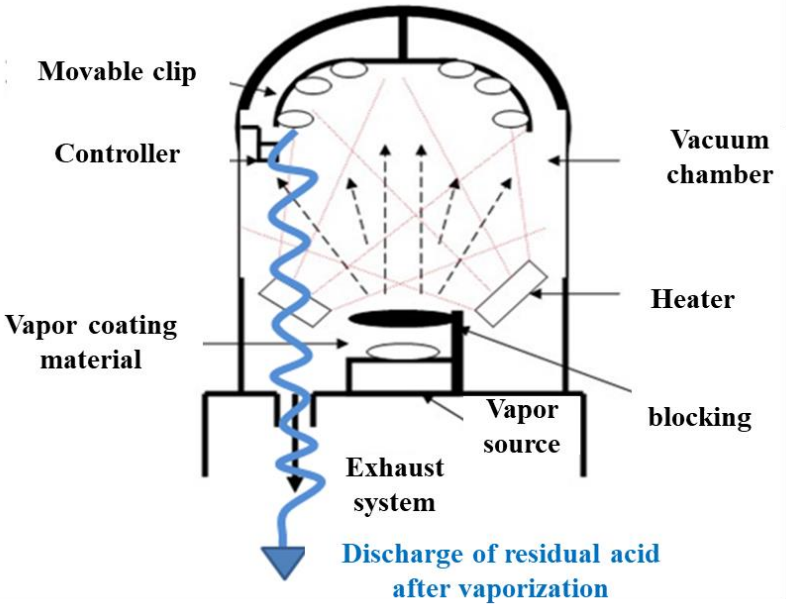


Figure 7. Extend the processing time of the vapor deposition.

Project ID: 13
Project Title: Handy Deskmate —An Innovative Design of Desktop Organizer
Team member(s): Tien-Lun Liu, Ming-Cheng Tsai, Hung-Huai Shen, Ling-Hsiang Hsieh
Organization/Dept: Chung Yuan Christian University

Project Briefing

I. Motivation and objectives

3C products have brought convenience and connected to our life. Multi-functionality and flexibility with customized requirements are still the major directions for product innovation. Therefore, this project explores the needs from office workers, and then an integrated desktop organizer is designed to provide flexible storage and functions to make use of 3C products effectively and improve the work efficiency in the office.

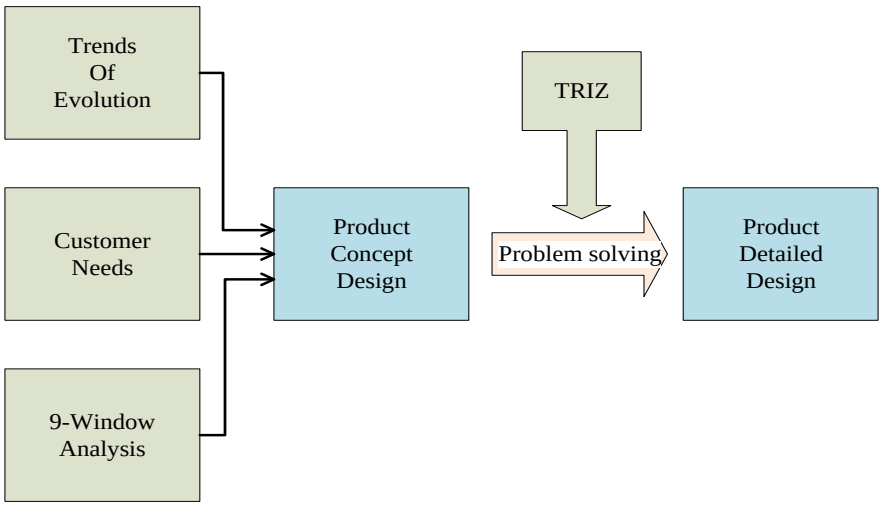
II. Features of the project

1. Office storage function for different office stationery, cell phone, etc.
2. Customizable storage space / functional modular design.
3. The expandability of functions with USB connections.
4. Color management for job priority.

III. Value and Contributions

1. This product can effectively store office stationary to keep our desk from messy, such as the penholder, Post-it notes, and cell phone. We use the modular design to allow the users to assemble for their desired shape, size and storage space to meet the customization requirements.
2. The way to assemble our product is simple. We assemble each components of our product by magnet connection and we can control our product easily due to the N-S magnetic pole.
3. In order to utilize the functions of mobile phones effectively, it provides the need for mobile phone integration, including viewing, charging, storage, etc.
4. The integration with USB may add more possible function expandability to this product. For example, USB small desk lamps, small fans, etc. can be connected to this product when needed, greatly improving office convenience.

IV. The ideas generation process



1. Concept Design：

I. Collect customer needs from those who usually work in the office.

(1)、 Easy use and installation

(2)、 Keep the desktop well-ordered

(3)、 Durability

(4)、 Multi-functionality

(5)、 3C product integration

(6)、 Diversified needs from different users

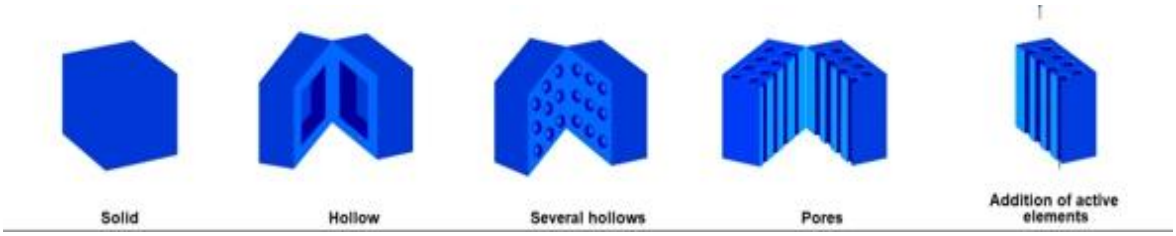
(7)、 Keep office work efficiently

II. Apply **trends of evolution** to generate design concepts, including :

(1)、 “Mono-Bi-Poly(Various)” to increase user’s convenience.

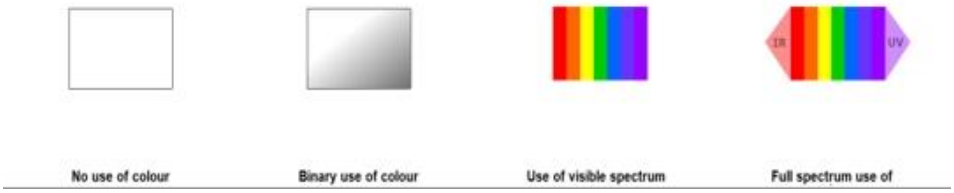
Acquired design concepts: multi-functionality with modularity

(2)、 "Space Segmentation" to add the hollows and active elements to our product.



Acquired design concepts: hollow structure and magnet for assembly.

(3)、 "Increasing use of color" to enhance not only appearance but also recognition.



Acquired design concepts: color management for job priority.

III. Apply 9-window analysis to help us to think more about what we can do in our product.

	PAST	PRESENT	FUTURE
SUPER SYSTEM		Environment (Stationery、Phone、Notes)	Charge cell phone.
SYSTEM	How product was assembled	Desktop organizer	To-do list
SUB SYSTEM		Components design	

2. Detailed Design：

We apply contradiction analysis to solve the problems encountered in the detailed design as follows :

Problem 1：the demand for customization of desktop organizer appearance.

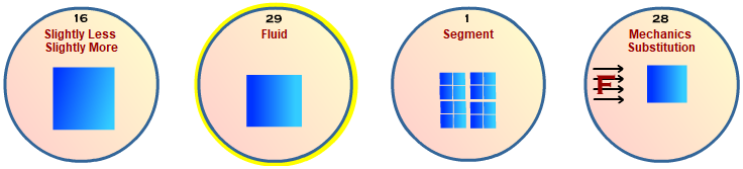
- The improving parameter: shape(12).
- The worsening parameter: Device complexity(36)
- Suggested inventive principles:

16 insufficient/excessive function

29 Use gases and liquids

1 Segmentation

28 Mechanics Substitution



Suggested inventive principles	Conceptual Solutions
1 Segmentation	Modular design
28 Mechanics Substitution	Assembled by magnetic field
16 insufficient/excessive function	Add more or less modules according to customer's requests

Problem 2: Increase the length of the note slot

- The improving parameter: Length of stationary object(4)
- The worsening parameter: shape(12)
- Suggested inventive principles

13 Other way round

14 curve

15 Dynamize

7 Nested Doll

Suggested inventive principles	Conceptual Solutions
15 Dynamize	The note slot is extendable
7 Nested Doll	The note slot can be overlapped

Project ID: 14
Project Title: A Portable Seating Assist Device
Team member(s): Yu-Gang Chen, Jo-Peng Tsai
Organization/Dept: Far East University

Project Briefing

I. Motivation and objectives

In addition to a variety of major diseases, the most common problem that plagues the health of the elderly is that they are difficult to sit and get up from chairs, sofas and toilets, etc. because the knees are aging or unhealthy. Although there are many products on the market that can help the user to gradually tilt from the original seat to help get up from the chair. However, due to the lifting mechanism is built into the seat, the entire set of seats is complex and expensive, and cannot help most people who need assistance. (Fig.1)

This portable seating assist device is designed to be portable and can be applied on one chair to the others to help the elderly standing up much easier with less cost.

Fig.1 Power-assisted raising chairs on the market

II. Features of the project

1. With the simple design of the motor and worm gear mechanism, it generates great upward thrust.
2. AC and DC dual-use design, suitable for indoor and outdoor use.
3. A normal power bank is enough to drive the motor when in the outdoors.
4. Built-in compression springs generates auxiliary thrust and reduces overall volume and cost.
5. The upward thrust comes from the sum of three designs, the motor horsepower, worm

gear labor-saving mechanism and built-in compression springs.(Fig.2-Fig.3)

(c) Starting position, elastic potential energy is stored in the compression springs.

(a) Middle position, the compression springs are releasing energy.

(b) Highest position, the compression springs have completely released energy.

Fig.3 Motion analysis of the seating assist device

III. Value and Contributions

1. With the design of pre-loaded thrust, compression springs help increasing the thrust.
2. Most patients can afford it thanks to small size, labor saving and low cost.
3. The seating assist device can be moved anywhere at any time. It is suitable for both indoors and outdoors. It increases the mobility of patients with knee problems and enhance their willingness to move to more places.
4. More convenient and less expensive than existing products on the market.

IV. The ideas generation process

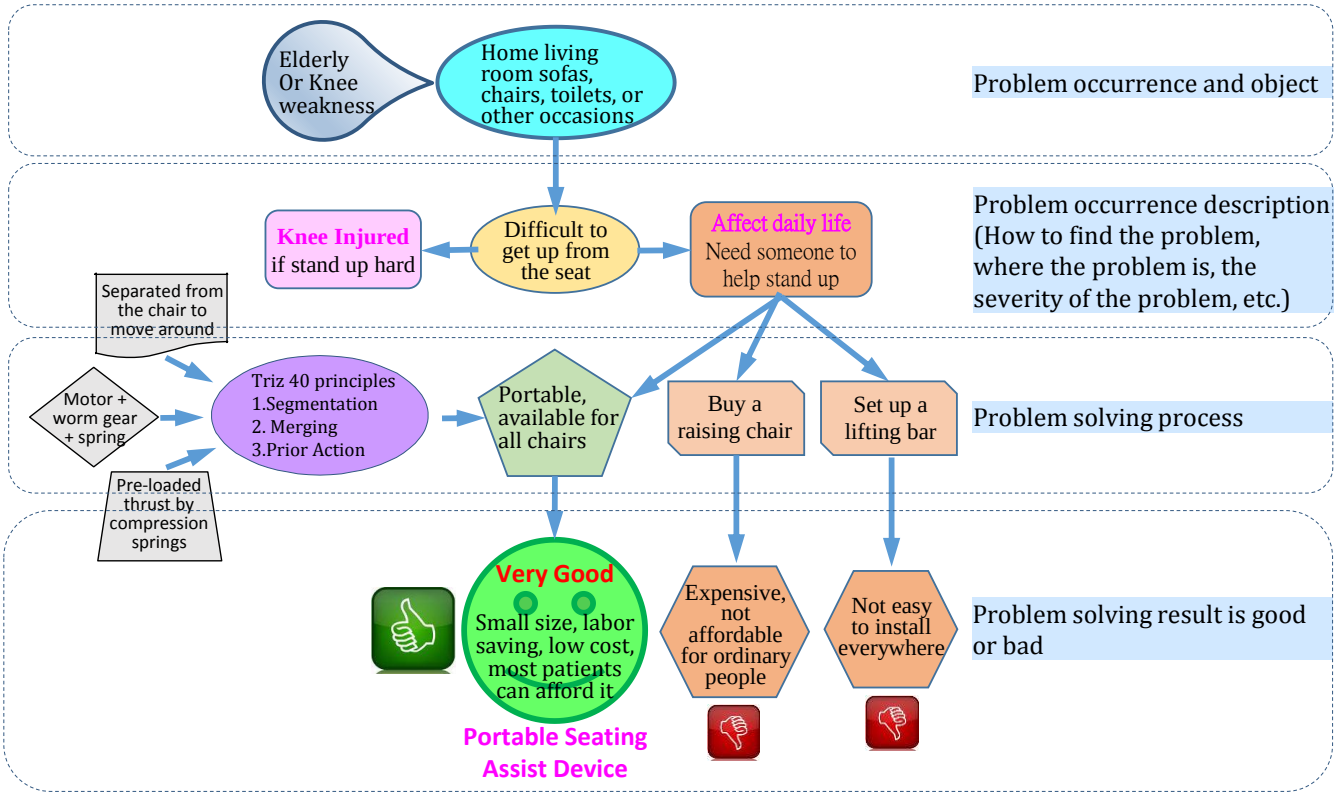


Fig.4 The ideas generation process

Project ID: 15
Project Title: New Approach to Respiratory Rate Monitoring Device using TRIZ
Team member(s):TriZit Benjaboonyazit, Tayard Desudchit
Organization/Dept: Chulalongkorn University

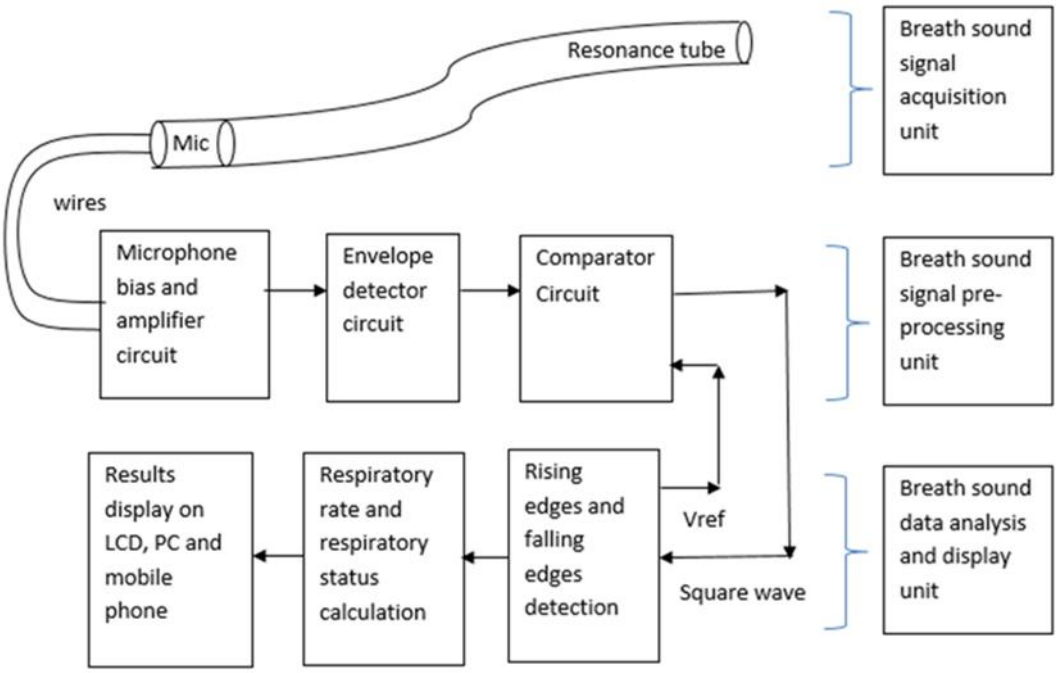
Project Briefing

I. Motivation and objectives

Respiratory rate is one of the important vital signs besides pulse rate, blood pressure and body temperature (Evan et al. 2001). An abnormal respiratory rate can be a significant indicator of serious illness such as cardiac arrest (Creikos et al. 2008). Respiratory rate monitoring plays an important role in intensive care unit (ICU) (Neideen, 2012) and is one of the fundamental indicators in sleep study (polysomnography) (Barbieri et al. 2018). Furthermore, as people become more health conscious nowadays, practices of mindfulness using breathing become more wide spread as it is believed to be the best tool for maintaining good health both physically and mentally (Jacobs et al. 2011). Besides, there are not so many precise portable and low-cost Respiratory Rate Monitoring Device in the market**.**

II. Features of the project

The project has features of breath-to-breath respiratory rate monitoring with high accuracy and low noise**.** It is also capable of analyzing breathing status. Details is as in the following figure.
The microphone is inserted and fixed at the end of the tube in catching breath sound signal from the mouth and/or nose. The signal is amplified and passed into envelope detector circuit after which it is compared with a suitable reference voltage in the comparator circuit to generate a pulse train of square wave synchronized with the respiratory cycle. A simple algorithm is developed in a small microcontroller (PIC16F628A) to detect rising edges of each consecutive square wave to calculate respiratory rate and display it on LCD together with analysis of
breathing status. It can detect breath sound as far as 250 cm from the nose and can perform accurately and more responsively with wide range of speed and level of breathing as tested against End Tidal CO2
Capnography device. The result shows the developed device can estimate precisely from as low as 0 BrPM to as high as 98 BrPM and is also capable of detecting shallow breathing. It is believed that it has high potentials for detecting hypopnea besides apnea event.

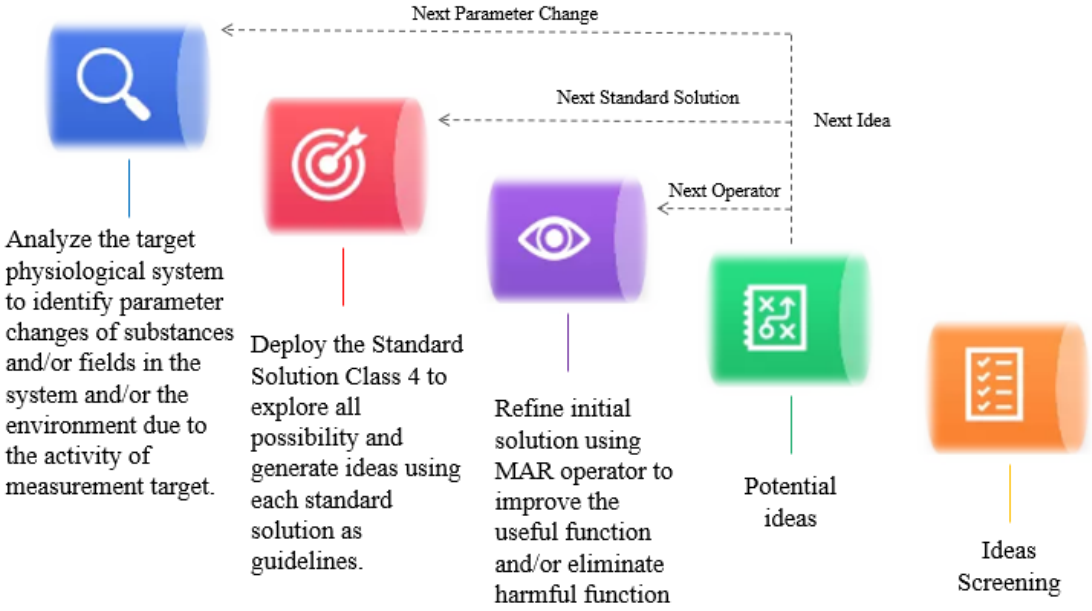


III. Value and Contributions

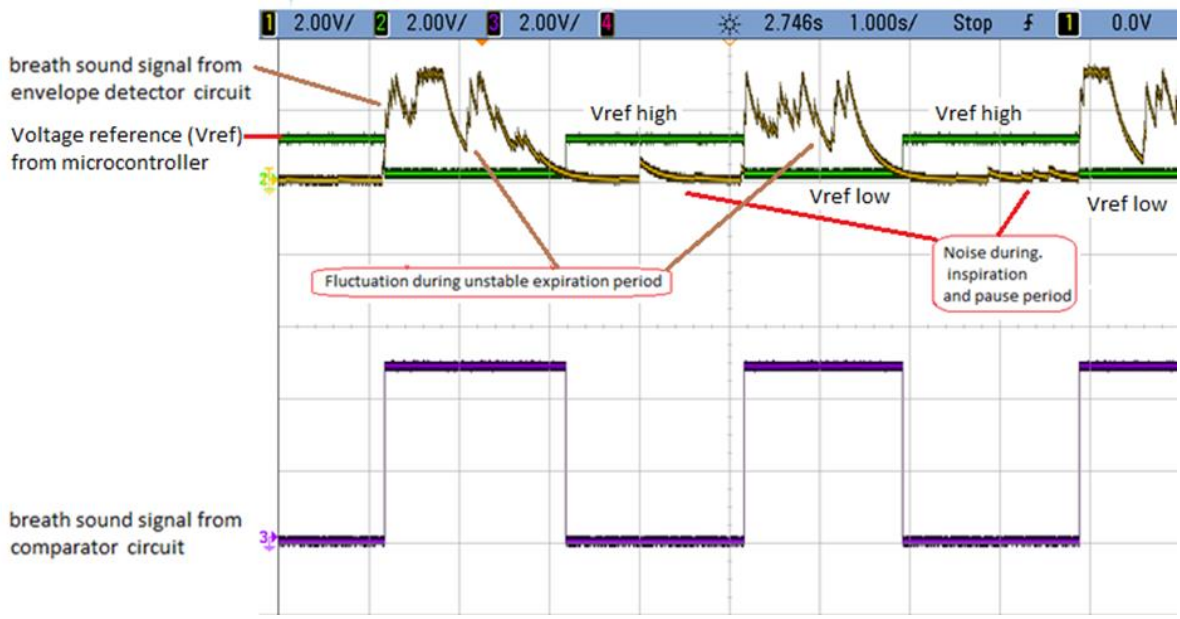
It has the value of continuously and remotely monitoring the respiratory rate and will contribute to the health conscious society which is a big market.

IV. The ideas generation process

There have been several researches on various kind of methods and technologies developed to measure respiratory rate using parameters changes in the physical, chemical or biological elements inside and outside the body of human that are caused by respiration activities . In the author's previous paper (Benjaboonyazit, ICSI-2018), the model for idea generation process in medical devices development using TRIZ has been proposed as shown in the following Figure. The idea generation and problem solving process used in this study can be generalized to be utilized in the development of other medical devices, besides the respiratory rate monitoring device. The generalized development process can be summarized into three major parts, i.e., the analysis of the physiological system to identify parameter changes of substances and/or fields in the system or its' environment due to the activity of measurement target, the deployment of the Standard Solutions Class 4 to explore all possibility and generate ideas using each standard solution as guidelines and the refinement of initial solutions using MAR Operator to improve the useful function and/or eliminate harmful function.



TRIZ's Standard Solution No. 4.3.2 Applying Resonance Oscillations of a Sample
If it is impossible to directly detect or measure changes in a system, and passing a field through the system is impossible as well, the problem can be solved by generating resonance oscillations of either the system as a whole or a part of it; variations in oscillation frequency provide information about changes in the system.
In order to evade noises which will cause errors and artifacts in the measuring system, the reference voltage is creatively designed to intelligently adapt itself to be low during expiration period and to be high during inspiration and pause period using the concept of resolving contradiction in the theory of inventive problem solving (TRIZ). This makes the developed device simple and low-cost with no need for complicated filtering system.



Project ID: 16
Project Title: New product identification and design using affinity measures and super-system trimming: Example of Multi-functional Stick
Team member(s): Dongliang Sheu, Chia-Lin Ho

Organization/Dept:

Project Briefing

I. Motivation and objectives

When designing a new product, there are two issues of concern: 1) How to identify ideas for innovative products, 2) How to design a product with best set of functions and minimum components to minimize ideality. This research suggested systematic methods to address these two issues with several examples and this project presents the example of Multi-functional Stick.

II. Features of the project

TRIZ device trimming primarily deals with trimming components within a system. We propose a novel trimming strategy and process for identifying new product concepts by trimming components and integrating various systems at super-system level using affinity index and Dendrogram. The 9-window and Scenario Analysis were used to identify needed functionalities and potential relevant multiple systems at supersystem level to trim. The multiple related systems forms into a large "virtual" system. Then, related components of the large virtual system are trimmed and integrated forming a new system of a multi-functional product. An affinity relationship matrix is built to manifest the affinity between components. Dendrograms are then built to determine the best component set for integration through trimming. The final integrated system will have fewer components than the sum of the components of the original cumulative systems while maintaining the cumulative main functions. This methodology has been implemented in several systems. The example of a multifunctional stick is presented.

III. Value and Contributions

The contributions include: 1) Proposing an integration process to identify multiple systems to be integrated into an integrated functional system with less components; 2) Proposing a mathematical technique to assess the likelihood for integration of component groups, assisting users in identifying the priority for trimming. This will also make the trimming

process more objective instead of relying on human individual judgement or inspiration; 3) Extending the traditional scope of TRIZ trimming from within system to super-system trimming.

IV. The ideas generation process

5.1 Overall Process

Refer to Figure 1. The overall process of identifying new products through super-system trimming can be described as follows:

Stage 1: Identify and select initial target systems in the super-system for potential integration. 12 Windows and Scenario Analysis tools are used to identify potential systems for integration. Verify utilities of the selected systems. This is explained in Section 5.2.

Stage 2: Perform Component Analysis for all systems selected as target for trimming and integration. By breaking down all the first level of components for each super-system, potential components for trimming and merging are exposed. Details are explained in Section 5.3.

Stage 3: Calculate affinity measures for each component pairs of all relevant systems. The affinity indices represent the suitability for the corresponding components to be integrated or merged. The higher the affinity between two components, the more suitable that the two components can be merged. Definition of affinity index between any two components, regardless if they were from the same or different systems, are calculated based on six aspects of indices. They are: Function similarity, Time Compatibility, Space Compatibility, Material Compatibility, Connectivity Closeness, and Product Hierarchy Closeness. The affinity sub-indices from each of the above-mentioned categories are weighted and added to form the final affinity index between each pair of the components. These indices are indications for integration suitability. The strategy is that the components of higher affinity indices are better suitable for merging and integration through component trimming. Definitions for those indices are explained in Section 5.4.

Stage 4: Establish dendrogram for grouping and ranking of the affinity indices. A dendrogram is a representation map of affinities between components showing the “closer” components being putting together for merging and integration. The dendrogram is used to identify components of high affinity for merging. The process of determining component sets for merging are explained in Section 5.5.

Stage 5: Attempts to merge component sets based on the cut dendrogram built in Stage 4. This is indicated in Stage 5 on Figure 1. Regular trimming process and trimming rule C or E of TRIZ trimming tools can be used in this process to merge multiple components into one. Details can be seen in Section 5.6.

5.2 Identification of target systems in the super-system

I) 12 Windows consideration

An initial system is defined as the physical system of interest upon which we would like to build a more functional system. It may also have some problem or have something to be improved. A super-system, in its narrow sense, is defined as some systems or components outside of the subject initial system and possibly in its nearby space or time domain. A broad sense super-system is the union of the subject system and its super-system. In this paper, we are using the broad sense super-system for definition. The goals of this project are to propose a systematic new strategy to identify new products based on integrating and trimming components in the super-system. The first Stage is to identify target systems upon which we can integrate thus eliminate their components to form a more concise system which can perform the sum of all existing functions from the target systems whose components are merged. This is a new strategy for developing new products with less components. The 12-Window analysis and the Scenario analysis are used in this article to identify target system for integration and trimming.

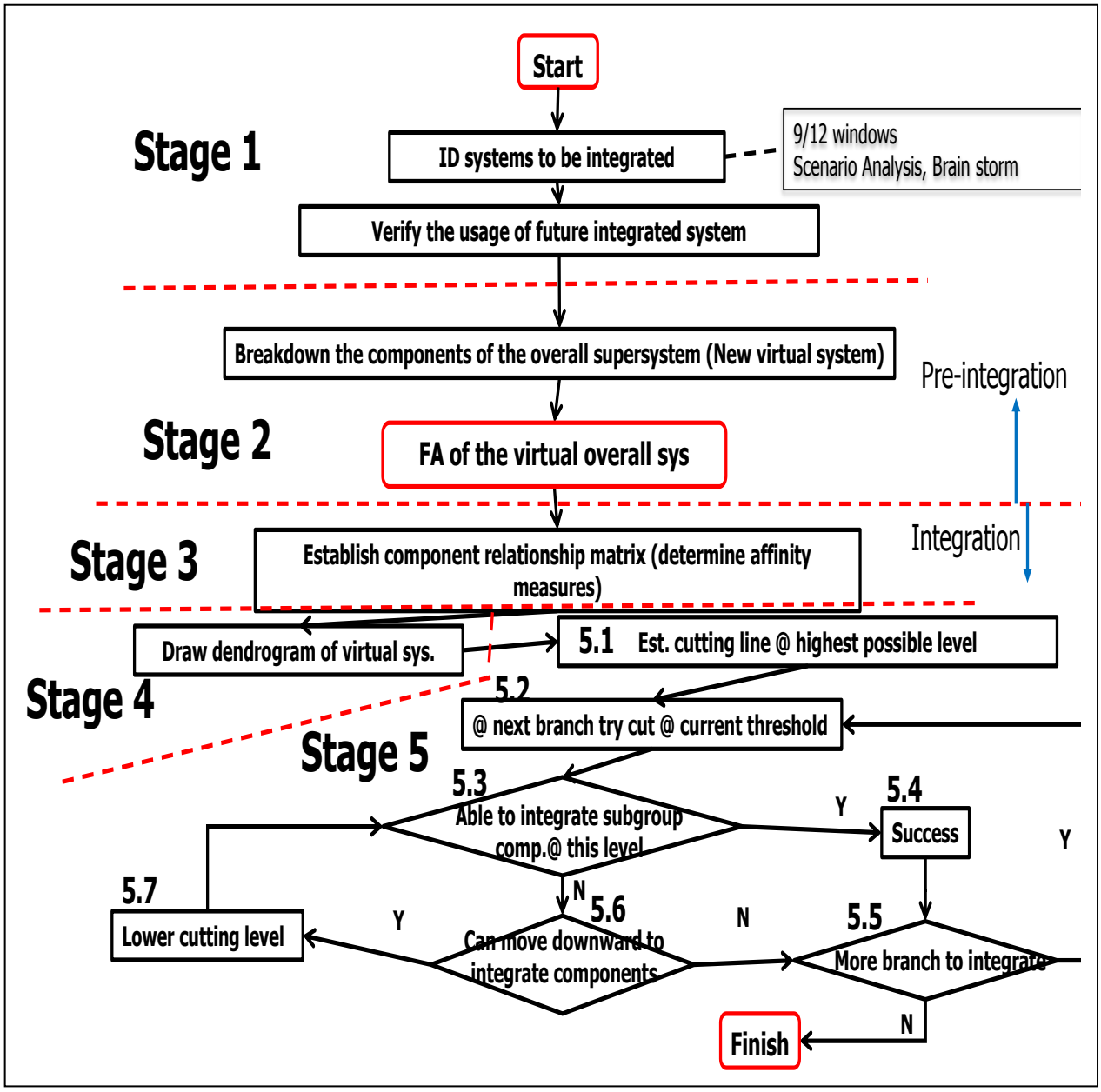


Figure 1. Overall Product ID and Trimming Process

Figure 2 shows the format of a 12 windows method. The sub-systems are the components of the subject system. The original form has the 9 windows including 3 levels of systems (Super-system, System, and Sub-system), and 3 time frames (Past, Present, and Future). Recent studies have extended it into 12 windows to include negative/alternative systems. On the horizontal axis, there are the past/present/future scenarios. On the vertical axis, there are system/sub-system/super-system on the upper 3 rows and the negative/alternative systems occupying the same row. Sheu (Sheu and Lee, 2011) defined the negative system can represent any of the below scenarios: 1) the system whose function is to the opposite of the subject system. For example, sleeping pill is to get into sleep while alarm clock is to wake up.; 2) the system which is used to correct or modify the results of the subject system. For example eraser vs pencil; 3)

the system which is used to destroy the subject system. For example, a bomb to a house; 4) the system which can interfere, eliminate, or retard the function of the subject system. In the case of an alternative system, the systems which can be taken into consideration include a competing system or a complimentary system. A competing system is another system which can perform the same function on the same object of the function. For example, both a car and a bike can carry a person from one place to another. So, they are competing with each other. Complementary system is a system which can work together with the subject system toward same purpose. For example, a spoon and a fork can complement each other while eating foods and drinks. Given a subject system in the middle of the 12windows, at the System-Present cell, the 12windows allow us to identify other relevant systems which the subject system may be able to merge with for more useful functions with less cumulative number of components.

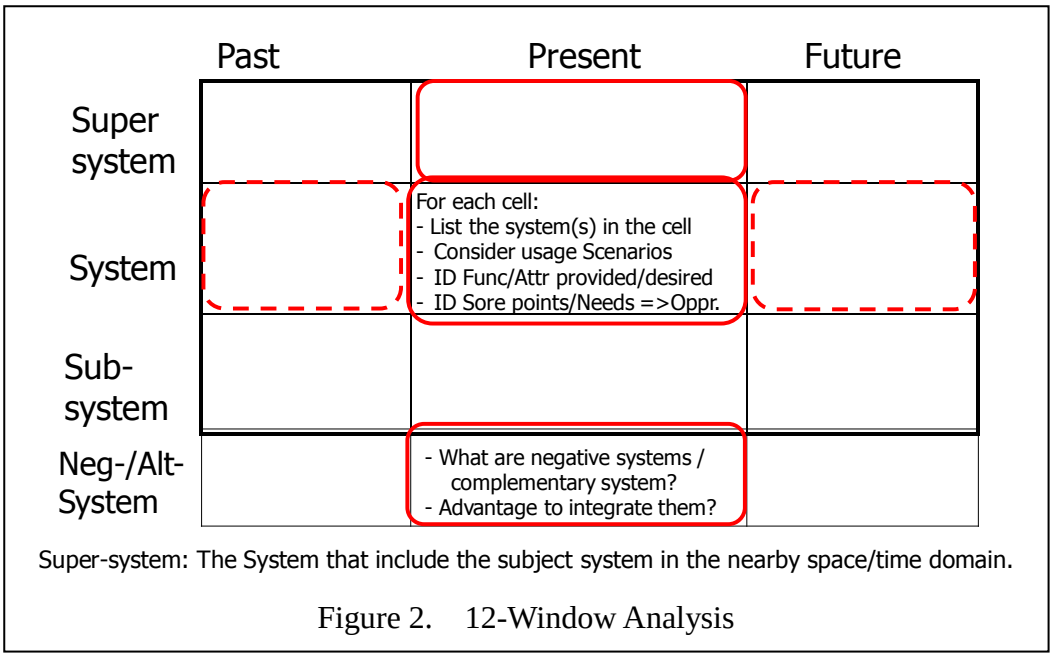


Figure 2. 12-Window Analysis

II) Scenario Analysis

A form for Scenario Analysis is given in Figure 3. The form is used to describe scenarios for the use of subject system. By going through the detail scenarios of the usage process of the system, other systems involved in the scenarios can be identified and used as potential target system for merging and integration.

Scenario Name:

Subject system:	Related product:
Place: Timing:	People involved:
【Describe the scenario the product is being used so that the needs during the usage process can be identified. These needs can serve to help us identify some other products involved in the usage process for merging and integration】	【Photos or videos】

Figure 3. A form for Scenario Analysis

5.3 Component Analysis of all the cumulative super system

In this step, first level decomposition of all components of the targeted systems are listed. All the functions for all these components are tabulated and the functional model of this big "system" is presented. This is to prepare for the next steps of calculating affinity indices among all components regardless if they are in the same system or in separate systems. The useful functions of the components are particularly of interest as later trimming involves combining components providing same or similar functions. The harmful functions are of little concern except that the components providing harmful functions would have higher priority to be trimmed thus eliminating the harmful function.

5.4 Calculate affinity measures for each component pair of all relevant systems.

The authors propose the affinity measures for each component pair to comprise 6 categories of sub-indices, namely: 1) Function Complementarity; 2) Time Compatibility; 3) Space Compatibility; 4) Material Compatibility; 5) Component Connectivity Strength; 6) Product Hierarchy Consideration. The final affinity index between the two components is the weighted addition of all these 6 aspects of the sub-indices. Detail definition of the value for each category of index and their corresponding weights are explained below. The idea is that higher the resultant affinity between the pair of components, the more likely that the two components should be integrated and the two components is trimmed into one. Notice that the affinity values assigned to each situation are reference numbers. Intermediate values can be assigned if actual situations fall in-between two listed situations in the tables. Detail specific numbers can be adjustable providing the general rule of thumb are observed.

(1) Function Matching/Complementarity

Components having similar functions, regardless from the same or different systems, are more likely integrated into one component. When the user attempts to integrate multiple different components, the component's functional features, movement and target object must be considered. Thus the features of the functions are mapped from strong to weak as qualitative

numbers in Table 1.

Table 1. Index Rating of Function Complementarity

Type of situations	affinity value
Two components having functions with same object, similar function, or using same actions for their functions.	0.9
Different object of functions but with same function or similar action principles.	0.7
Same target, different function.	0.5
Without any of the above situations.	0

(2) Time Compatibility

Based on the integration of the two functions from the two components, if the two functions are mutually incompatible to be performed at the same time, a negative affinity index of -1 is assigned for the affinity. If they are performed in a different time, some partial points can be applied to indicate the affinity. If the two functions from the two components in issue are compatible to be performed at the same time, median affinity is used. If the application time for the two function are different, a much higher affinity index can be used to encourage merging and integration of the two components. The assignment of the affinity indices in these various situation are shown in Table 2.

Table 2 Reference Affinity Sub-indices for Time compatibility

		Functions of the two components	
		incompatible	Not incompatible
Time of application	Same	-1	0.5
	Different	0.5	0.9

(3) Space Compatibility

When integrating different system components, the physical space of the components is a resources that can be used toward integration. The quantitative values for component space compatibility are shown in Table 3.

Table 3. Qualitative Table for Space Compatibility

Types	Qualitative value

Having complimentary shapes.	0.9
Having similar or the same shape.	0.6
Having incompatible shape for integration.	0

(4) Material Compatibility

When two components are intergraded, the material's characteristics must be considered. If the marital is similar or compatible, the two components can be intergraded. When searching for new function carriers, the components material must be complimentary. Thus, a table of the quantitative value indicating the strength between component materials is shown in Table 4.

Table 4. Qualitative Table for Material compatibility

Types	Qualitative values
The two components have similar or the same material characteristics.	1
The two components have different material characteristics.	0
The two components have incompatible material characteristics.	-1

(5) Component Connectivity Strength

Two factors contribute to the Component Connectivity Strength: Connectivity Relationship and Connectivity Distance as shown in Figure 4. Lee and shin (1993), Lee and Wang (1993), and Lee (1994) defined Types of component relationships as indicated in Table 5.

Inspired by Chou's (2004) ideas for component connectivity relationship used to determine which set of components are more likely to be grouped as sub-assembly, this research used the similar idea to identify the affinity between components for merging through integration and trimming. Figure 4 and Table 5 are integrated to form the rating of Component Connectivity Strength as indicated in Table 6.

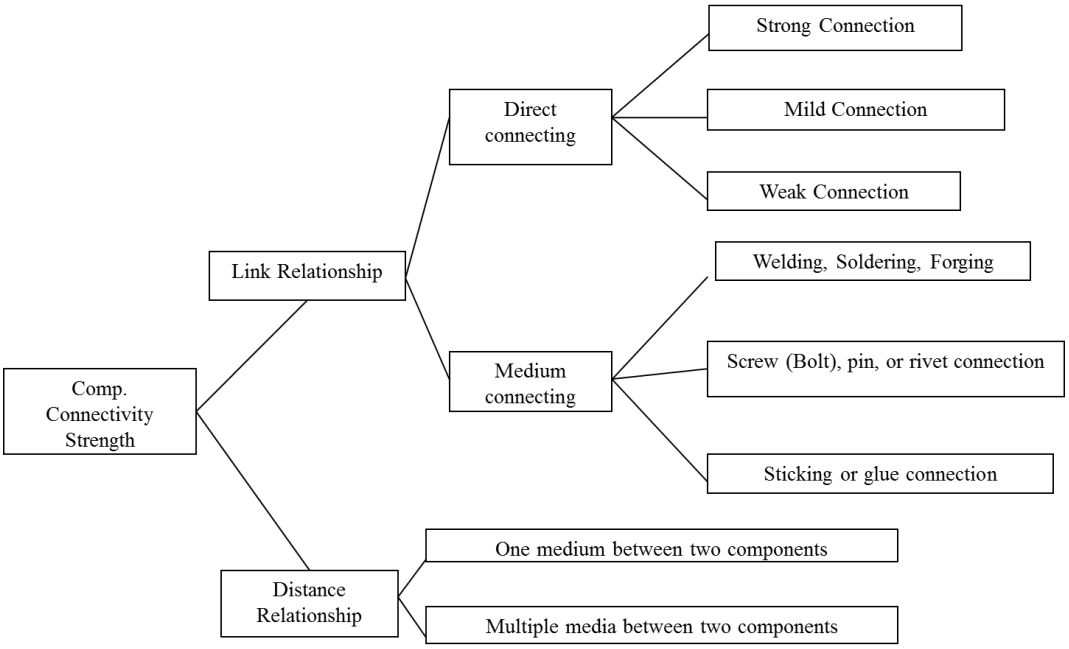


Figure 4. Component Connectivity Strength

Table 5. Types of component relationships

Connection forms	Content description
Connection Types	
Light connection	If two components have a simple relationship and does not need to apply force to have a connection, touch…etc., for the two components to execute their activities, they are considered loosely connected.
Mild connection	If two components have a relationship which requires force be applied to have a connection or to touch, etc., for the two components to execute their activities, they are considered intermediately connected.
Strong connection	If the two components have a complex interaction requiring additional force to push, squeeze, twist, rotate, etc., to complete its interacting activities, these two components are strongly connected.
Connection Medium	
Welding, melting, forging	If the two components require welding, melting, forging to preform component activity, the two components exist a temporary component relationship.
Screw (bolt), pin or rivet	If the two components are connected though a screw, bolts, pin or rivet, the two components considered to be temporarily connected component relationship.

Stick-ing or glue to connect.	If the two components exist a gluing substance to connect the components when performing their activity, the two components are considered temporarily connected.

Source: Lee and shin (1993); Lee and Wang (1993); Lee (1994)

Table 6. Quantitative values for Component Connectivity Relationship

Type	Value
Strong connection	0.6
Mild connection	0.4
Light connection	0.1
Welding, melting, forging	1
Screw (bolt), pin or rivet	0.7
Stick-ing or glue to connect.	0.3
Medium btween two components	0.1
More than one medium between the two components	0

(6) Product Hierarchy Consideration

Figure 5 shows a product hierarchy de-composition of a hypothetical system. The system (12) is de-composed into Sub-system 1 (Component 7) and Sub-system 2 (Component 8) with respect to the System 12. The Sub-system 1 is further decomposed into Component 3 and 6 and so on as shown on the Figure. When integrating two components, it is easier and more natural to integrate nearby components in the product hierarchy than integrate much far away components on the hierarchical tree. Based on this idea, the Authors define the number of step jumps between two components as the links we need to travel from one component to the other component on the product hierarchy. For example, one cross jump on the same hierarchy is needed from component 1 to component 2. One upward jump is needed from Component 1 to Component 3. Jumping from Component 1 to Component 9 will require 2 upward jumps (C1->C3->C7), one cross jump (C7->C8) and one downward jump (C8->C9). That is a total of 4 jumps. Table 7 gives an example of affinity value assigned between two components. If the two components are on the same hierarchy needing only one cross link jump from one component to the other, the affinity index for the pair of the components is assigned 0.9. If the two components are one upward or downward link jump, the index is 0.7 as indicated in Table 7.

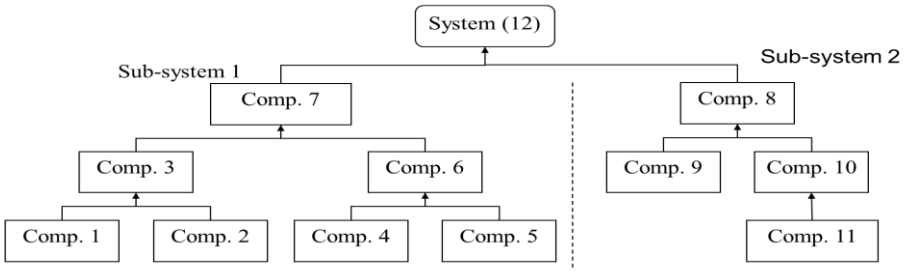


Figure 5. Product Hierarchy Decomposition

Table 7. Table of the Product Hierarchy Consideration

# of link jump needed from one component to the other	affinity value
Two components are apart by one cross link jump	0.9
Two components are apart by one upward or downward link jump	0.7
Two components are apart by one upward and one cross link jumps	0.5
Two components are two levels apart with two upward or two downward link jumps	0.3
More than two jumps apart.	0

The final affinity index for each pair of components, *i* and *j*, are calculated based on the accumulation of weighted sub-affinity indices from the above mentioned 6 aspects of indices using Eq. 1.

$$x_{ij} = w_F F_{ij} + w_T T_{ij} + w_S S_{ij} + w_M M_{ij} + w_H H_{ij} + w_L L_{ij} \quad \text{Eq. 1}$$

Where:

i, j : The component identification whose affinity index are being calculated.

x_{ij} is the final affinity index between components i and j. This value falls between -1 and +1.

F_{ij}、T_{ij}、S_{ij}、M_{ij}、H_{ij}、L_{ij} are the six relationships indices between *i* and *j*. They are function complementarity, time compatibility, space compatibility, material compatibility, Component Connectivity Closeness, Product Hierarchy Consideration, etc.

$w_F, w_T, w_S, w_M, w_H, w_L$ are the weight of corresponding 6 aspects, respectively. The weight of

each factor is between 0 and 1, the sum of the six component relationships is equal to 1.

The Affinity Relationship Matrix can thus generated based on x_{ij} for all i and j. Figure 6 shows an example of Affinity Relationship Matrix of 9 components.

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	-	0.30	0.22	0.05	0.32	0.23	0.15	0.02	0.37
C2		-	0.23	0.07	0.58	0.23	0.58	0.02	0.43
C3			-	0.58	0.53	0.13	0.15	0.02	0.15
C4				-	0.07	0.58	0.02	0.02	0.02
C5					-	0.32	0.53	0.13	0.43
C6						-	0.15	0.02	0.45
C7							-	0.22	0.52
C8								-	0.22
C9									-

Figure 6. An example of affinity indices with 9 components.

5.5 Establishing dendrogram and grouping components for merging

This is the Step 4 in Section 3.1. A dendrogram is a tree-like diagram frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering. Dendrograms are often used in computational biology to illustrate the clustering of genes or samples, sometimes on top of heatmaps. [Wikipedia 2015]

The process of building a dendrogram starts with the components with highest affinity indices and link them with a horizontal line at the level of their affinity index as shown in Figure 7, {(X2, X7), (X3,X4), (X4,X8)} The, the components with lesser affinity values are brought in the diagram one-by-one until all links are taken care of.

The next Stage is trying to cut across vertical linking lines on Figure 7 to form groups of components. The components which are still linked after successful cuttings are supposed to be integrated into one new component. Figure 8 shows this process. The TL #'s are the Trial Lines which we attempt to achieve for grouping of all components under the trial cutting line into one component. For example, TL 1 would indicate the attempt to merge all components, X1 to X 9, into a merged component. TL 2 indicates the attempt to integrate X2, X7, X3, X4, X8, X5 into a merged component. The CL lines are the successful cutting line which the designer is able to

merge all the components under the CL to form a merged component. For example, the successful CL 1 indicating that the designer is able to merge or replace X2 and X7 with one component. The eventual example indicates a final integrated system containing a component replacing (X2, X7) => Y1, a component replacing (X3, X4, X8) => Y2, X5 remains the same, a component replacing (X1, X9) => Y3, and the component X6 remains the same. This becomes a new innovative system that is able to use 5 components (Y1, Y2, X5, Y3, X6) to perform the cumulative functions of the original multiple systems in the super-system level. This represents a new strategy to systematically identify and design a new and more concise product which can perform the cumulative functions of multiple likely-related systems using Affinity indices, super-system trimming strategy, and TRIZ trimming methods for actual merging and integration. The Trimming methods will be described later.

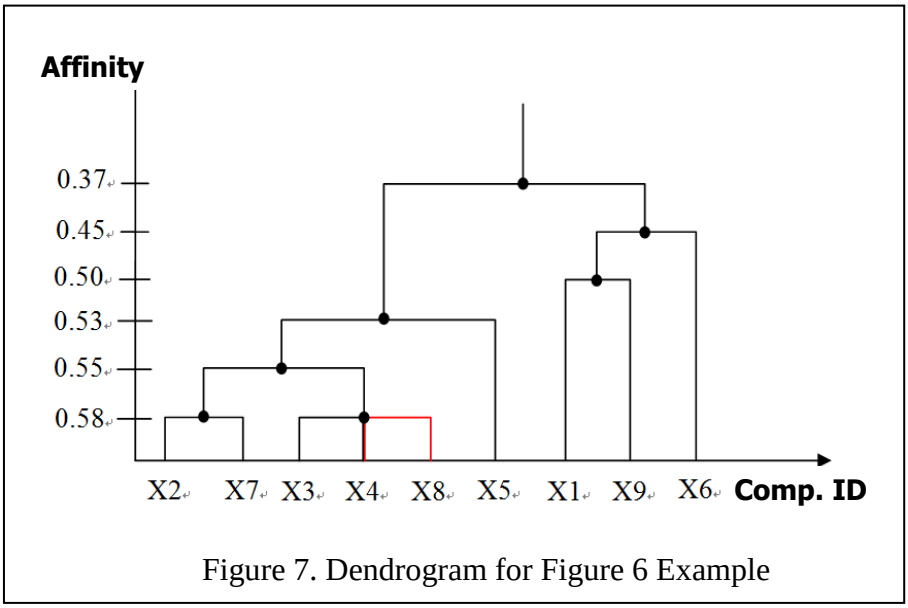


Figure 7. Dendrogram for Figure 6 Example

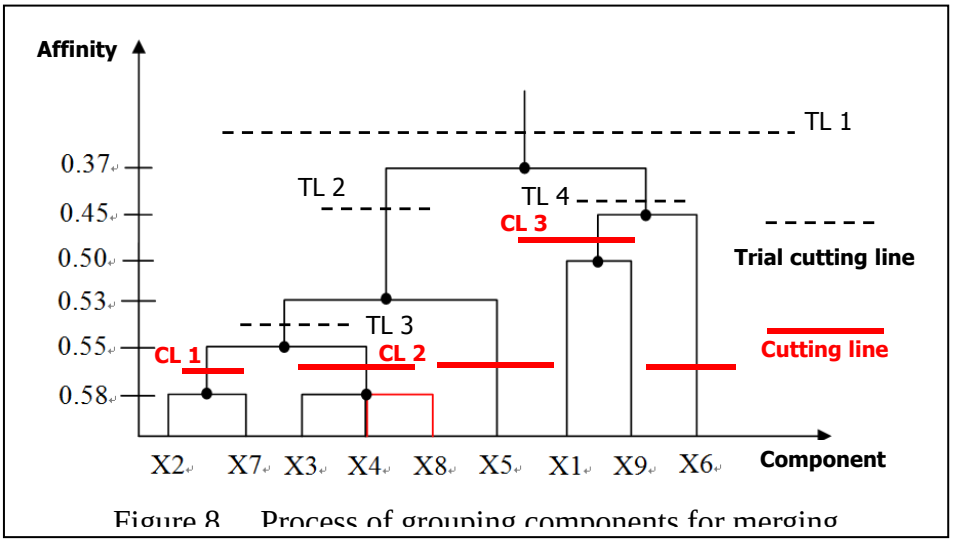


Figure 8 Process of grouping components for merging

5.6 Approaches to integrate components based on TRIZ methods

Once a trail cutting is set on Figure 8, the TRIZ trimming methods can be used to trim components in its under-layer system. For example, TL 3 would call for the designer to merge X2, X7, X3, X4, and X8 into one component. CL 3 would call for a merging of X1 and X9 components. To actually achieving these requests, the designer can either use brain storming method to conceive the solutions or better use the TRIZ systematic method to achieve solutions. The below TRIZ tools can be used to achieve the components merging. Refer to (Sheu, D. D. and Hou, M. (2012) and Sheu, D.D. 2015 for details of using TRIZ for component trimming. Due to space limitation, only the brief concepts are presented in this paper.

5.6.1 Component merging using trimming techniques

Our goal is to trim at least one component in the component group in the mean time keeping the function(s) of the group of components or making them un-necessary.

Merging 2 components means that at least one of the components must be trimmed. In TRIZ trimming modes, there are 6 trimming rules which can be used to trim one or multiple of the components in the group of components to be integrated.

1) Rule X: a component can be trimmed, if its function is no longer needed. This may be achieved by having a different super-system component taking up the function.
2) Rule A: a component can be trimmed, if the object of it function can be eliminated.
3) Rule B: a component can be trimmed, if the object of the component's function can serve the function by itself.
4) Rule C: a component can be trimmed of another component can assume the function(s) of the component to be trimmed. The other component can conveniently be other components in the group after the cutting line assignment in Figure 8.
5) Rule D: Function carrier can be trimmed if a new or niche market can be identified for the trimmed product. In this case, the function of the system may be degraded, but the ideality is still increased or maintained due to the reduction in costs/harm more than offsetting the reduction in the function/benefits.
6) Rule E: Another component is found which can take care of both functions delivered by the two components in the group to be merged.

The abovementioned rules can be used to conceive the methods for trimming some component for merging and integration. The 6 aspects of affinity indices are also indications that the components of higher affinity indices can be more conducive to be merged than irrelevant components.

5.7 Application Example: a case study

Alpenstock is an essential accessory for hiking. Whether it is hiking uphill or downhill, it can protect the knees and reduce the effort. The knees and the feet must bear the body weight and the weight of the hiking equipment. When the knees are put under stress for a certain

amount of time, the knees will suffer from attrition. Yet climbers are required to bring a complete set of equipment for their safety and climbing needs. If the load is reduced, the danger of this sport can also be reduced. There is a need to have less equipment components, and thus weight, and still have enough of the functions the set of equipment can provide.

Stage 1: This Stage used the window analysis and scenario analysis to identify intergradeable components for the target system.

Table 8 uses 5W1H1G questionnaire format to identify other systems in the super-system as potential targets for integration. Table 9 lists various systems in the super-systems with their past-present-future cases to identify potential systems for integration.

Table 8. Problem Descriptions

5W1H1G	Description
1. What is problem? (sore point)	In addition to alpenstock climbers must also carry other tools, such as compass, flashlight, lighters…etc. It is difficult to carry so many tools.
2. When was it happen?	When hiking.
3. Where is it found?	On the mountains
4. Why?	To avoid dangers when climbing mountains.
5. Who?	Hikers, mountain climbers
6. How was it happen?	In addition to an alpenstock, climbers also require a flashlight, lighter, and other tools for emergencies.

Table 9. 9/12 Window Analysis

	Past	Present	Future
Super system		Grass, branches, other road obstacles. Wild animals: (protection, danger)、Sun(for shade) Dark night: lighter, flashlight Tent (support): Swiss army knife.	human slope/ stairs (support) flat land
System	In factory assembly (ease of manufacturing)	Alpenstock (protection, support)	Worn-out alpenstock. Rusted alpenstock Environmental burden

Negative system			
Alternative system			

Some potential systems which may be useful during the use of the alpenstock may include: the flashlight, lighter and Swiss Army Knife with alpenstock to conduct multi-system integration. Considering the past and future situations, it is also desirable to have the materials for such new system environmental sustainable and easy to manufacturing in the factory. These later features are noted for designers but do not need to be involved in the component integration/merging processes.

Stage 2: Component and Function Analysis

Based on the other target systems identified, component and function analysis are performed to identify components for integration. To conduct function analysis, components are disassembled and their individual functional relationships are identified, as shown in Figure 9. They are: 1. Nozzle; 2. Nozzle base; 3. Spark ignition system (Spark generator); 4. Lighter fuel (Fuel); 5. Fuel chamber; 6. Lighter switch (Control switch); 7. Flash handle; 8. Battery; 9. Light base; 10. Light bulb set; 12. Control button; 13. Swiss knife tool set (Tool set); 14. Swiss knife handle (Knife handle); 15. Key chain; 16. Shock absorber cushion (Cushion); 17. Alpenstock body (Stick body); 18. Alpenstock handle (Stick handle).

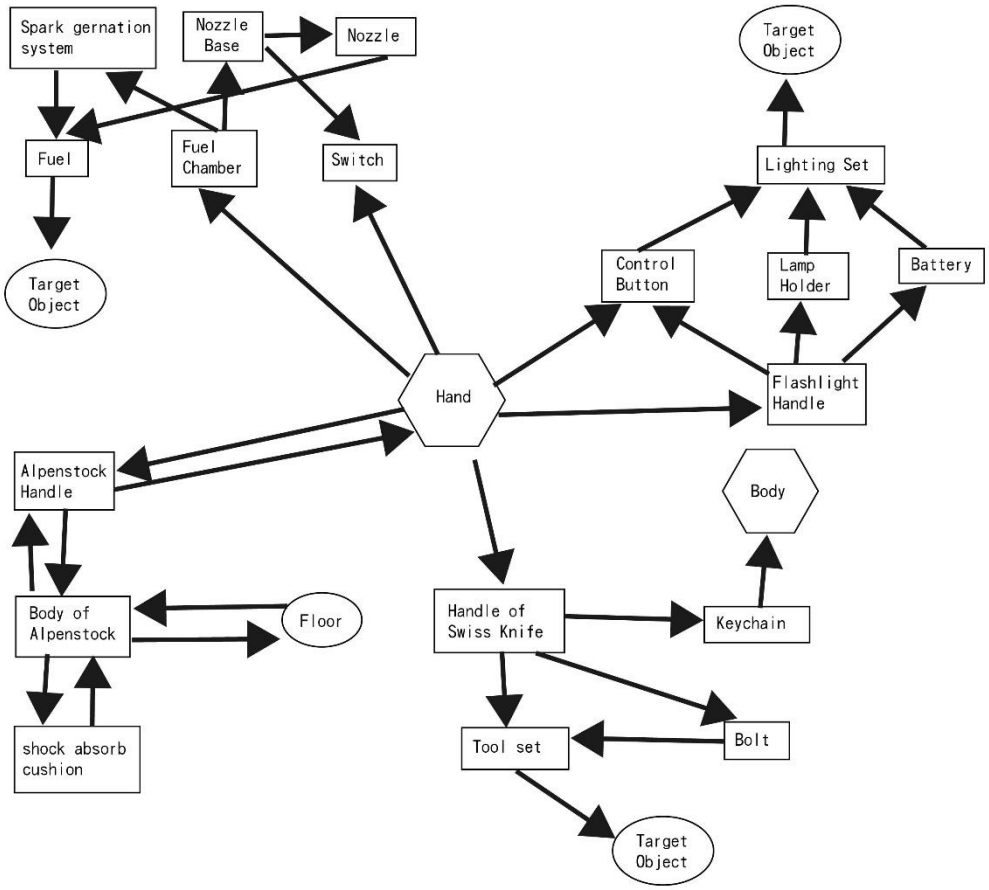


Figure 9. Function Analysis

Stage 3: Calculate Affinity measures for each component pair

In this stage, components are analyzed based on function analysis with 6 aspects of sub-affinity indices as mentioned before. The Affinity indices between each pair of components are calculated based on the methods mentioned in Section 3.4 and Eq. 1. Note that the relative weights among the 6 factors can be adjustable. In this case, the six weights are weighted equally as 1/6. The Component Affinity Matrix is given in Figure 10. To save space, the component ID on the top row of the Figure 10 corresponds to the component identification numbers and component names on the left column exactly and in same order.

Stage 4: Establish Dendrogram

Based on the component relationship matrix in Figure 10, a dendrogram is established as shown in Figure 11.

Stage 5: Merge component sets based on the cut dendrogram built in Stage 4.

In this Stage, the authors started trail cut from the highest level (lowest affinity level) on the dendrogram for component grouping. The processes are indicated as Stage 5 (5.1~5.7) on Figure 1.

In this case, the first cutting can be performed between values affinity values of 0.32 to

0.37 where the dendrogram suggested to integrate Lighter switch and Flashlight switch. According to Sheu (2011) on methods to exercise trimming, when using the invention principles for trimming, principles number 2(taking out), 3(local quality), 5(merging), 20(Continuity of Useful Action), 25(self-service) and 40 (composite materials) can all be considered. By using inventive principle #5, Merging, to support the trimming rule C, the "lighter button" and the "the flashlight switch" both control their system's functions by turning off and on. It is therefore possible to change the two two-position on-off switch to one 3-position, Light-on/Flash-on/Off switch as shown in the far right picture of Figure 13.

The second cutting line can be between affinity index of 0.38~0.47. Dendrogram on the right side of affinity 0.47 implied (Swiss knife tool set and Key chains) or (Bolt and Key chain) may be merged. It is doable to include the Key chain as one of the several tools of the Swiss knife tool set and delegate the manufacturing of the tool set to the tool set provider. As such, the Key chain can be "trimmed" from our scope of design. The other way of merging the bolt and key chain may be making an end of the bolt to contain a keychain circle. However, this is not preferred.

The third cutting can be performed at affinity between 0.52 and 0.58. The dendrogram suggested two groups as follows:

(1) To group Swiss knife handle and Alpenstock handle into one component.

(2) To group the following components to perform merging and integration: Nozzle base, Fuel chamber, Alpenstock body, Flashlight handle.

To achieve grouping of (1), it makes sense to use trimming rule C by assigning Alpenstock handle to serve as the handle of Swiss knife and embed the tools of the Swiss knife inside the Alpenstock handle as shown in Figure 14.

To achieve grouping of (2), the challenges are: How can we make one component to assume the useful function of another component. Trimming methods as described in Sheu, D. D. and Hou, M. (2012) along with TRIZ inventive principles, Trends, and Effect database can be used to do the job.

At the end, the below trimming and integration can be achieved:

A) The function of fuel chamber, holding the fuel, can be assumed by the Alpenstock body. Thus the fuel chamber can be trimmed.

B) The keychain can be absorbed into the tool set and delegate the tool set manufacturing to a sub-contractor. As such, the keychain is practically eliminated from our work scope.

C) The alpenstock can assume the functions of the flashlight handle thus the Flashlight handle, which also used as battery holder, can be trimmed.

D) The alpenstock body can be made hollow to hold the battery, light generation system, and fuel. The TRIZ Trends of Space Segmentation was used to make this design. (Mann 2007)

E) The nozzle base and the Flashlight base can be built on the alpenstock body by modifying some parts of alpenstock body and making it heat resistant with proper materials. In this way, the nozzle base can be feature transferred to some part of the alpenstock body. The inventive principle #3, Local Quality, can be applied for this purpose.

The final system will integrate the functions of Alpenstock, Lighter, Flashlight, and Swiss knife tool set into a system while is able to perform all the functions of the four constituent systems with reduced components. The concept design of the new and component-reduced integrated Multi-functional Stick is shown in Figure 15. Figure 16 shows the integration of various components into the internal hollow space of the alpenstock body.

The original total of 18 components is decrease to 12 which include: Stick body, Stick handle, Shock absorber, Light bulb set, Nozzle, Nozzle base, (Swiss knife) tool set, Spark generator, Battery, Control switch, Bolt, and Fuel. All-in-all, the trimmed components are: Fuel chamber, Flashlight handle, Flashlight base, Swiss knife handle, Keychain, Lighter control switch. Table 10 shows the improvement of 33% part count reduction while achieving a new innovative and integrated product design. It appears that using the super-system integration and trimming strategy proposed by this paper can be used for innovative new product identification and design effectively.

	2 Nozzle Base	3. Spark ignition sys.	4. Lighter fuel	5. Fuel chamber	6.Control switch	7. Flashlight handle	8. Battery	9. Light base	10. Light bulb set	11.Control button	12. Knife tool set	13. Bolt	14. Knife handle	15. Key Chain	16. Shock absorber	17. Stick body	18. Stick handle
1. Nozzle	0.30	0.22	-0.03	0.32	0.23	0.15	-0.02	0.15	-0.02	0.15	0.32	0.32	0.15	0.32	0.15	0.15	0.15
2. Nozzle base	X	0.23	0.07	0.58	0.23	0.32	-0.02	0.43	0.03	0.20	0.20	0.32	0.48	0.20	0.20	0.48	0.48
3. Spark ignition sys.		X	0.07	0.32	0.13	0.15	-0.02	0.15	-0.02	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
4. Lighter fuel			X	0.07	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
5.Fuel chamber				X	0.32	0.52	0.13	0.43	0.03	0.20	0.20	0.32	0.42	0.20	0.20	0.58	0.42
6.Control switch					X	0.15	-0.02	0.15	-0.02	0.37	0.15	0.15	0.15	0.15	0.15	0.15	0.15
7.Flashlight handle						X	0.22	0.52	0.13	0.30	0.20	0.32	0.48	0.20	0.20	0.58	0.48
8.Battery							X	0.22	0.00	0.08	-0.02	-0.02	-0.02	-0.02	-0.02	0.13	-0.02
9.Light base								X	0.07	0.32	0.15	0.27	0.43	0.15	0.15	0.43	0.43
10.Light bulb set									X	0.07	0.03	0.03	0.03	0.03	0.03	0.03	0.03
11.Control button										X	0.20	0.20	0.20	0.20	0.20	0.20	0.20
12.Knife tool set											X	0.47	0.30	0.47	0.20	0.20	0.35
13.Bolt												X	0.47	0.47	0.20	0.32	0.32
14. Knife handle													X	0.30	0.20	0.48	0.58
15.Key chain														X	0.20	0.20	0.20
16.Shock absorber															X	0.30	0.30
17.Stick body																X	0.52
18.Stick handle																	X

Figure 10. Component Affinity Matrix

$$x_{ij} = \frac{1}{6}F_{ij} + \frac{1}{6}T_{ij} + \frac{1}{6}S_{ij} + \frac{1}{6}M_{ij} + \frac{1}{6}H_{ij} + \frac{1}{6}L_{ij} \quad Eq.1$$

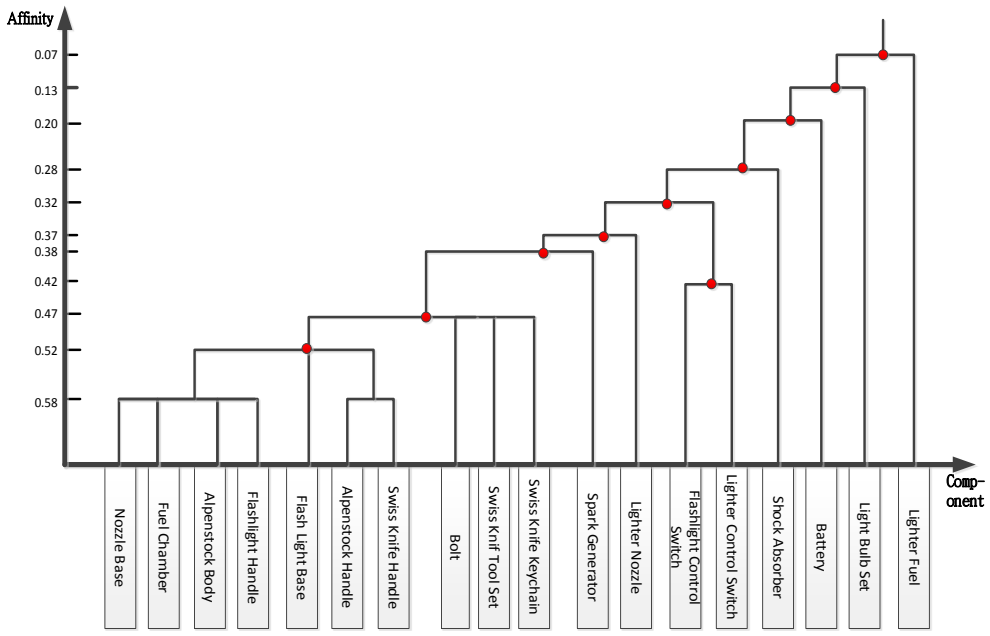


Figure 11. Dandrogram of the Case

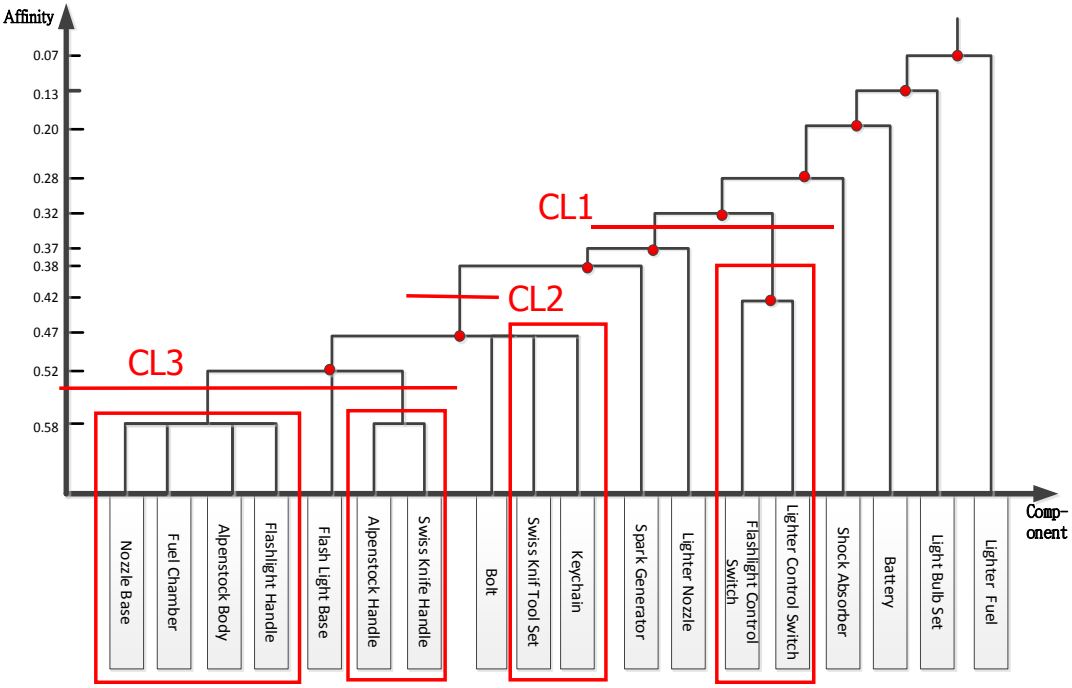


Figure 12. Cut-lines of the Dandrogram

Figure 13. Integrated figure of a lighter button and flashlight switch.

Figure14. alpenstock handle and Swiss knife handle are integrated

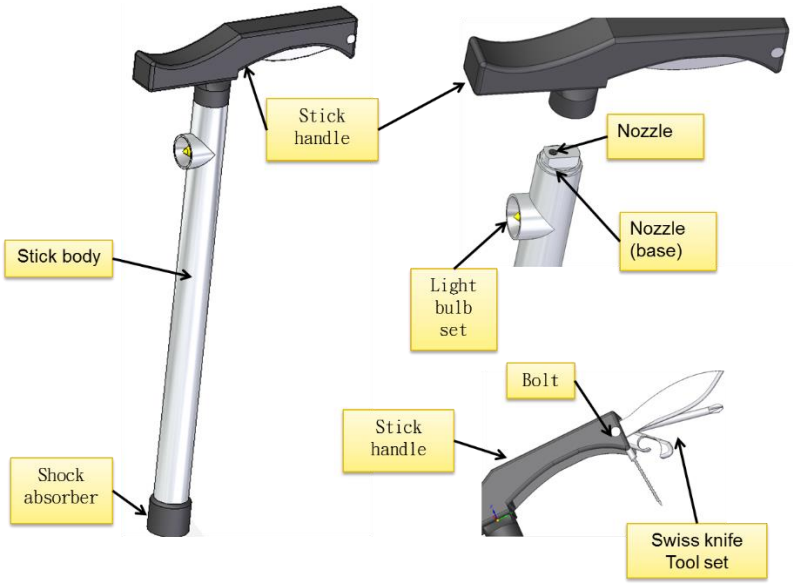


Figure 15. Integrated Multi-function Stick

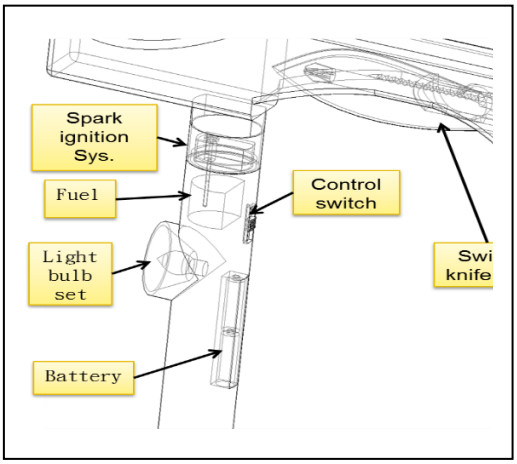


Figure 16. Components integrated into the multi-functional Stick

Table 10. Assessment Table – multifunctional Stick

Item	Before	After	Improvement (%)
Total number of components	18	12	(18-12)/18=0.33%
Number of Trimmed components	-	6	-

.

Project ID: 17
Project Title: Multifunctional integrated desk and chair
Team member(s): Pei-Hsi Liu , Zheng Hao Chen, Meng Wei Ye , Zi-Qi Liu, Chen-Hui Wu , Sheng, Xie-Zhi

Project Briefing

I. Motivation and objectives

The invention can solve the problem that the school desk and chair occupy space, the seat height cannot be adjusted, and the desktop is too small to be convenient to use. Make it easier for students to use desks and chairs.

II. Features of the project

The invention provides a chair with a desktop and a chair back, it includes a seat and a chair board . The seat has a body for sitting on it, the seat plate is set in the seat body and is in an upright position or a horizontal position Transformation between flat positions. When the seat board is in the upright position, it is erected on the rear side of the seat body, and can be used as the back of the chair at this time; When the seat board is in the horizontal position, it is horizontally placed on the seat body, and can be used as a table on the chair. The position of the chair plate can be changed to achieve the function of the table top and the back of the chair.

III. Value and Contributions

The invention can solve the problem that the school desk and chair occupy space, the seat height cannot be adjusted, and the desktop is too small to be convenient to use. Make it easier for students to use desks and chairs.

IV. The ideas generation process

Project ID: 19
Project Title: Based on the Innovation Case of ARIZ-85C Sprout Cultivation Machine
Team member(s): Demou Zheng, Daohua Xu, Kaiqin Xu, Yiqiang Wang
Organization/Dept: Fujian Ospring Technology Development Co., Ltd

Project Briefing

I. Motivation and objectives

Fujian Ospring Technology and Development Co., Ltd., established in 1999, is the leading enterprise in domestic drinking water purification and treatment area, which is also State Intellectual Property Enterprise, High-tech Enterprise, Fujian Innovative Enterprise which integrates R&D, manufacturing, sales and service as a whole. The Company (including the wholly-owned subsidiaries) has applied over 1,400 patents, in which 116 invention patents are authorized until now.

Around the end of 2015, two foreign businessmen came to Ospring Technology twice to discuss the project of sprouts cultivation machine. During the negotiation, they only showed us a picture of double-cylinder sprout cultivation machine and some basic background information. Finally we could not go further on the business for the price of such machine is too high. After that, our company decided to cooperate with others and seek development (of horizontal type equipment) in other cities. At present, we have collected two papers of single-cylinder sprout cultivation machine from Taiwan. By the thinking mode of TRIZ and preliminary analysis, shortcomings of the patents above was found. Therefore, when developing new product, the company is suggested to set "Patent Invention of Sprout Machine" as its annual innovation target, concentrate on realizing it and make some breakthrough.

II. Features of the project

1.Great significance of project research and development and patent layout

Through market and Internet survey, it is known that Chinese Mainland has not yet mastered the rotary sprout cultivation technology and owned its machine either. Once successfully developing new product and patent layout, it is expected to give birth to a new industry.

2.Creativity of patent breakthrough

With patent retrieval (navigation), there are more than 1,100 patents about horizontal type sprout cultivation machine and technology over the past hundred years, while no

more than ten patents are about rotary type sprout cultivation machine and technology. It can be said that the technology system has appeared the evolutionary trend of S-Curve and projected curve. To this end, patent invention and layout of the project highlights stronger creativeness.

3.ARIZ-85C helps for highly difficult patent invention.

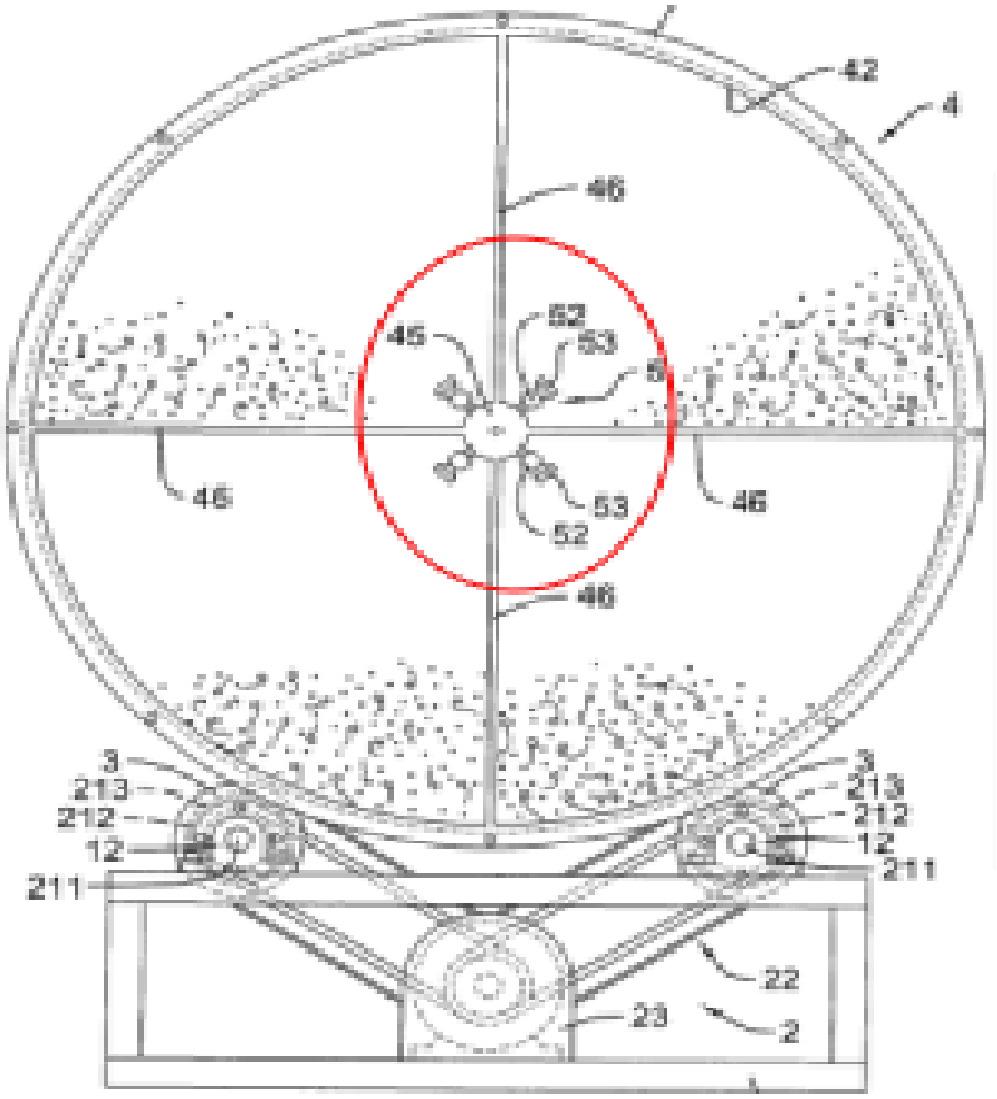
Facing the situation in which all we have are just one photo of equipment and two utility model patent (of single-cylinder type), we encountered many complicated problems-contradictions(whether the sprinkler is needed) and undefined components of the equipment . And these tricky problems can be solved only by using ARIZ-85C as the main tool. Besides practicing the entire nine steps of ARIZ-85C, new tools like flow analysis of TRIZ and patent knowledge(patent navigation, retrieval, defense and so forth) are necessarily added to work out the problems.

III. Value and Contributions

1. The use of ARIZ-85C in high-level patent invention is a nice and successful attempt.
2. The project is expected to exploit a new industry in China-Factory Sprout Cultivation Technology and Product. Some countries and regions in Asia have already done it.
3. We can also work on it in the near future, now let patent go first. The technology is predicted to provide Chinese customers a brand new enjoyment, for example, it can supply different people (even sappers on the ship, residents on the island, oil workers in the desert...) with fresh vegetables.

IV. The ideas generation process

The original idea of the project comes from target patent-Sprout plant breeding equipment CN200820142983.2（Attached drawing below）



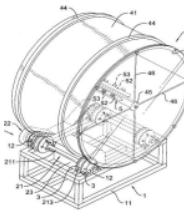
From the drawing, bent sprouts rolls forward in the capacity space of rotary cylinder. While for people who had learned TRIZ, it is easy for them to conjure up “Little Men Method” and the image of the “Little Men” rotating forward. During the process, some of them are impeded and battered by water pipe 52 and water injection nozzle 53, which might be the deficiency of this equipment. Now we improve the inadequacy of this patent, after that, it is possible to generate a new patent. Afterwards, the company decided to set the goal-patent invention. When associating with the “Little Men Method” applied in the problem-solving procedures of

ARIZ-85C again, it is because ARIZ-85C is specialized in dealing with complicated problems(especially for technology system with undefined components) and we could not distinguish related components of the equipment, so it is believed that using ARIZ-85C to solve problems and implement the goal of patent invention is worth a try.

The complete process of thinking (see chart below)

Ideas of generation process

0.Project Background

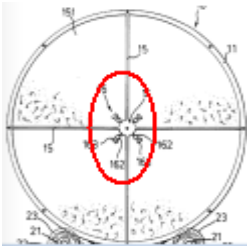


Idea

Project Development Team

Patent Creation Team

1、Problem-Finding:

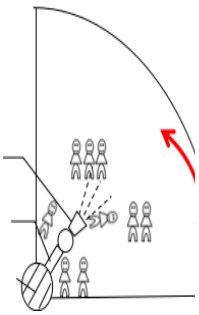


2、Problem Analysis：Little Men Method

Nozzle

Connecting Pipe

Transmission Shaft

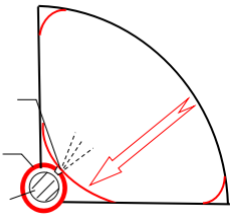


3、Problem Solving：Physical Contraction---Spatial Separation

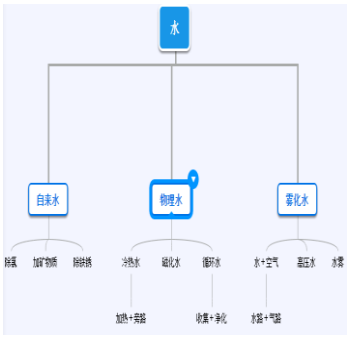
Spray Port

Casing Pipe

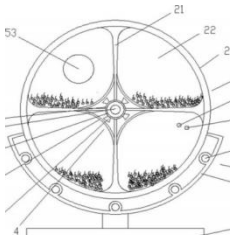
Transmission Shaft



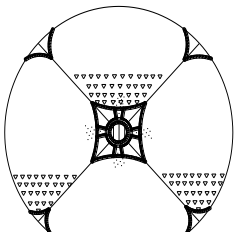
7、Water Resource Utilization：



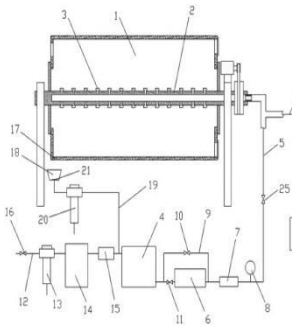
5、Existing System Solution：



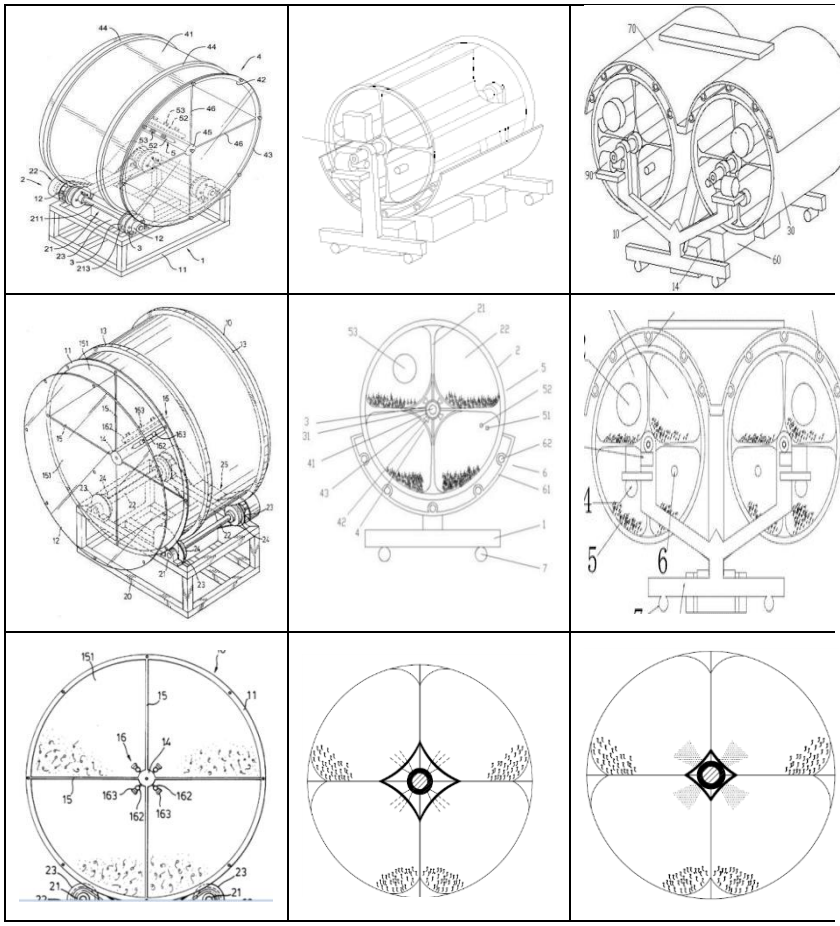
4、Subsystem Solution：



8.Alternative Plan：



6.Enlargement of Problem Solving：



10. Stage Results---17 Patent Applications: A Double-Barrel Rotary Sprouts Cultivation Device and Sprouts Cultivation Method. 2016201610162

9、TRIZ Applied in Patent Defense Analysis

11、Certificate of Patent for Invention（15）

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Project Briefing

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