

## A Creative Playground Design based on Universal Design: An Interaction Approach

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### Abstract

Problem solving algorithm of TRIZ<sup>1</sup> using a creative method can provide appropriate solutions due to its abilities in problem analysis. This method is a combination of knowledge and experience. Therefore it has called engineering of creativity. Organizing the required methods for providing the proper solutions in a way that the number of trial and errors limited to 10% is one of the main advantages of TRIZ for problem solving. This research aims to design a playground equipment based on universal design method. Lack of suitable play equipment for interaction between disabled and healthy children make an interruption to communicate with each other effectively. Therefore, disabled would be isolated in the society. The overall goal of this research is to provide a base for a proper interaction between ordinary and disabled children designing a playing tool for ordinary parks (not those specially designed for disabled children). In this research, a creative method based on TRIZ was introduced to design the playground equipment for children (healthy and disabled). A questionnaire was used to ensure its consistency. Cronbach's alpha of questionnaire determined is 0.955 which shows the validity of this research.

**Keywords:** Creativity design, TRIZ, Playground equipment, Universal Design Social interaction.

### Introduction

Play roles as an important part of children's activity to learn and understand about materials, people and society (Ginsburg, 2007). Even these days, play is a suitable method to recover the inpatient children (Cecily Lynn Betz, 1983). Actually, children need to do movement and mobility so they normally play to make it happen. All children have a right to play even if they have some disabilities (physically or mentally) (Sepahpour 2012). Psychology researches in this field have indicated that most of the disabled children suffer mentally because they are isolated from other children. These children are suggested to join the society and share their time to play with healthy children. This method helps them to increase their physical and mental abilities\_(Samuel A, 2006). Nowadays, play design is an important field, so numerous experts focus to teach the children by special games (Kirriemuir and Farlane 2004).

That's why it's necessary to have universal design for playing tools in a way to reach the common use for both healthy and disabled children. Therefore, it is essential to use universal design for play grounds of children. Universal design is called product and environmental design which is useful for majority of people without any special conformity or modification whenever it is used. Although, universal design is not a design style, its principal uses commonly to design a product or environment to make it happen for the most of people to enjoy it easily. There are some other trends

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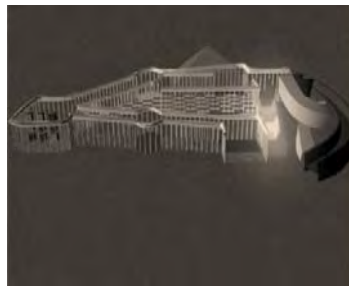
in the category of design such as barrier-free, technology assistive, design accessible which have often been mistaken with universal design. These types of design have been focused on disabled people, in which the process of design mostly is done for disabled people exclusively. In spite, for universal design, there are wider scopes of solutions with the purpose of helping to everybody and not just restricted to the disabled people (Edyburn 2010).

“The universal design”<sup>2</sup> has been divided into seven main principles; each one includes a subset which has called strategic design. It may not use all of these principles in a special design, however the important issue is globalization approach that should be considered by designers and manufacturer (Edyburn 2010). The principles are as follows: Equitable use, Flexibility in use, Simple and intuitive, Perceptible information, Tolerance for error, Low physical effort, Size and space to use.

There are numerous designed plays for healthy and disabled children whom suffering from movement disabilities. Figure 1 shows some especial designs of swing devices using for both healthy and disabled children. The second design is a type of slide which has been designed especially for wheelchair stay people (Figure 2). Figure 3 shows a rotational device to play both healthy and disabled children.



**Figure 1** The swings for wheelchair stay people.



**Figure 2** A type of slide for wheelchair stay children.



**Figure 3** A rotational device.

However, disadvantage of these types of design is lack of effective communication between healthy and disabled children. It means these types of plays have just been designed with the purpose of having simultaneous play of both healthy and disabled children. That’s why the research aims to design a play tool in which both healthy and disabled children participate and make communicate each other. Therefore, this research not only follows to gather healthy and disabled children in the playground in the same time, but also it prompts the children to influence each other. Hereto, algorithm of TRIZ\_(Salimi Namin, 2001) which means theory of invention problem solving was used. In this research for using of creative engineering to find an appropriate solution, three techniques of TRIZ were used. The techniques were used are ISQ (Innovation Situation Questionnaire), ideal solution method and 40 inventive principles (Salimi Namin 2008).

### **Creative design method**

#### ***Innovation situation questionnaire (ISQ)***

In creative engineering method, problem should be recognized initially. That’s why ISQ which is a descriptive method was introduced by Altshouler<sup>3</sup> to find the creative solution based on a

<sup>2</sup> Design for all

<sup>3</sup>Russian inventor 1925-1998.

standard questionnaire (Terninko et. al. 1998). In order to carry out the method of TRIZ, initially the problem should be defined precisely, and after realizing the different aspects, the surrounded systems will be conceivable. Therefore, all information related to the problem must be documented. Throughout the process of filling the ISQ, the questioner is asked to register any idea which is useful to solve the problem.

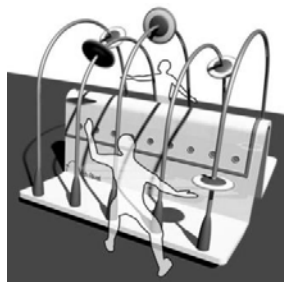
The steps of ISQ framework used in this study are as follows:

1. Gathering the information related to system and its surrounded environment.
2. The accessible resources.
3. The information about system situation.
4. Solutions for system modification.
5. The criteria for selecting the best solution ideas.
6. The history of the tested solutions about the problem.
7. Problem formulation method.

Each of the above process in the ISQ has some steps inside. The total questions should be answered are 29 items. One of the most important sections of ISQ is the study on the history of existed solutions. The historical study was done to initiate the information for starting brainstorming between specialists. Then in order to achieve to the most proper solution, all of the questions were answered by specialists within the brainstorming. Figure 4 to Figure 9 depict some significant items of these solutions by other researchers.



**Figure 4** The ancient rattles of pottery.



**Figure 5** An interaction and sense play.



**Figure 6** A soiling play.



**Figure 7** A strengthening the physical powers.



**Figure 8** A power reinforcement play device.



**Figure 9** An exercise horizontal playground equipment.

### The history of tested solutions about the problem

#### *Initial efforts*

Children have been usually attracted toward playing even they are infants. To enjoy this attraction they have started to make the simple toys for themselves and other people (Figure 4).

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***Modern efforts***

Nowadays, the solutions are developed based on new designs. Some playground equipment have been detected are shown in Figure 4 to Figure 9. Figure 7 and Figure 8 show the play equipment purposed the child's physical power reinforcement. Figure 9 shows a playground equipment purpose to reinforce the child's physical power. Although these play tools can be used for both healthy and disabled children, the interaction between healthy and disabled children is not well enough. TRIZ can be used to introduce the creative tools to solve this problem. Next session introduces the ISQ which is one descriptive technique of TRIZ for this purpose.

***Using Innovation Situation Questionnaire***

The questions of ISQ were answered by experts throughout the brainstorming meeting to reach some ideas to design a play device. The following concepts are the outcomes:

1. Involve various senses of children within the playground equipment.
2. Insert variety of playground equipment in the same play device.
3. Put potential skills of physical-movement disabled child in use in new design.
4. Create a proper place in park entrance for disabled children.
5. Make the playground equipment more attractive via combination of different playground equipment.
6. Create new playground equipment in order to make the playground equipment attractive than normal ones.
7. Use the current facilities for designing play tools.

***The ideal solution***

ISQ should be support by Ideal solution method in TRIZ to find the final design. In fact, one of the other useful techniques of TRIZ is answer of eight questions which cause to make strong the design system advantages and decrease its limitations. These eight questions had been answered by experts through the brainstorming meeting. The questions, coming as follows, are divided into two categories: useful function (UF) questions and harmful function (HF) questions.

***Useful function (UF) questions:***

- Does the useful function (UF) create some harmful outcomes?
- Does the useful function (UF) create some other useful outcomes?
- Has the useful function (UF) been depicted for substitution of harmful outcomes?
- Do we need any other useful functions (UF) to implement this useful function?

***Questions for harmful functions (HF)***

- Does the harmful function (HF) create some other harmful functions?
- Has this harmful function (HF) been created by some other harmful functions?
- Has this harmful function (HF) been created by some useful functions?
- Has any useful function (HF) been depicted for substitution of harmful functions?

In brainstorming meeting, experts replied the Ideal solution questions. The new solutions narrowed the solutions gained from ISQ steps. Also these questions enforced the useful functions suggested and decreased the harmful functions effects.

***Some outcomes of brainstorming solutions***

Figure 10 to Figure 16 Combining swing and Set assembled puzzle of tree shows that how devices can be designed based on brainstorming between experts. Also, it is possible to get pattern from some of the collective playground equipment to design a new attractive play pattern for children; for example it is possible to use other devices in the play (Figure 10 to Figure 16).

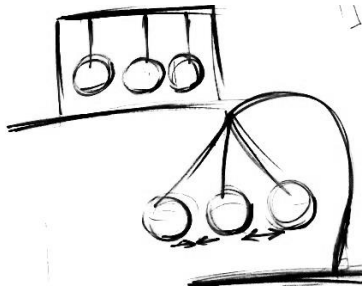


Figure 10 Ball swing.



Figure 11 Page sandy.



Figure 12 Seat pan interactive.

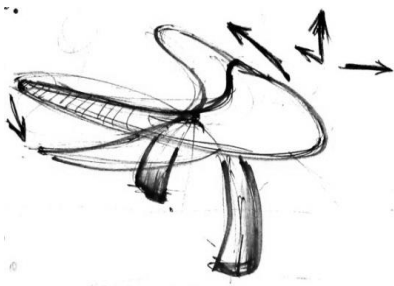


Figure 13 Combining slide and swing.

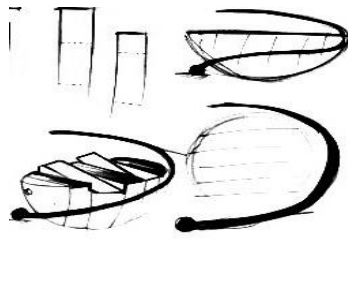


Figure 14 Combining Slides and swing sets.

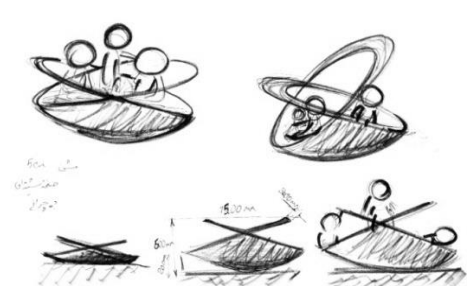


Figure 15 Combining Page sandy and swing.

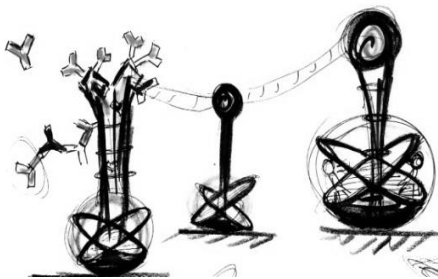


Figure 16 Combining swing and Set assembled puzzle of tree.

#### *Using 40 invention principles of TRIZ*

Altshuller presented TRIZ as a new method of thinking and he used it as a tool for growing skills (Salami Namin & Shahabi hagh, 2008). Surveying 200,000 inventions demonstrated that there are some key solutions in different fields of technology in various subjects by using similar solutions to get the appropriate answer. The table of 40 principles of invention has been depicted in a book titled as innovation algorithm of TRIZ (Tong, Cong, & Xiang, 2006). Using the table and 40 key solutions leads to decrease the number of trial and error because these tests have been done by lots of inventors in different fields and they achieved to these 40 proper solutions. Compare to other innovation orientated methods, TRIZ not only is able to find a solution related to the subject in the field of industry, but also it applies some solutions for solving problems in other fields. Actually, Altshuller during decades and after studying on 200,000 inventions found out that there are about 1500 technical conflicts which can be solved using 40 inventive principles (Tong, Cong, & Xiang, 2006).



There were some conflicts between the solutions suggested by the experts in ISQ and Ideal solution methods. Therefore the technical conflicts were compatible to the table of 40 principles of inventions to find the final design. The conflicts and the solutions for overcoming them are shown in Table 1.

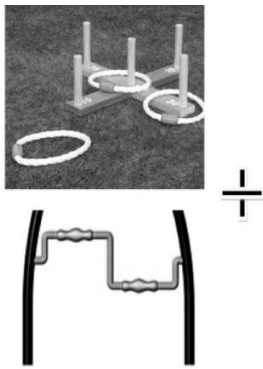
**Table 1. The conflicts and solutions extracted from table of 40 invention principles.**

<b>Resolving the paradox</b>	<b>Suggested 40 inventive principles</b>
Speed and Object-generated harmful factors	23/ Feedback, 28/Mechanics substitution, 35/parameter changes
Speed and Weight of moving object	13/The other way round
Area of moving object and Weight of moving object	17/Another dimension
Ease of manufacturing and Ease of operation	2/ Taking out, 13/The other way round, 5/Merging
Device complexity and Manufacturing precision	2/ Taking out, 18/ Mechanical vibration
Difficulty of detecting and measuring and Reliability	40/Composites materials
Power and Ease of operation	6/ Universality, 10/ Preliminary action
Reliability and Loss of Time	3/Local quality, 10/Preliminary action, 40/Composites materials

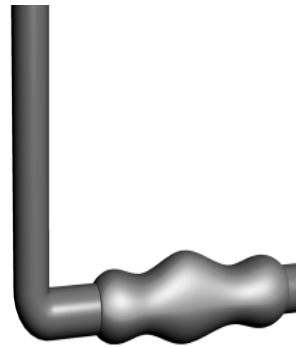
### **Results (Final Design)**

Some solutions were extracted to design new playground equipment using the techniques of ISQ, ideal solution and 40 inventive principles throughout the brainstorming meetings of experts. The solutions are as following:

1. Considering the safety tips, ergonomic tips and standards in the production.
2. Integrating different types of playground equipment for achieving the new playground equipment (17).
3. Giving common use for both healthy and disabled children.
4. Inserting dancing light in the play tool which gets its energy via the arms movement.
5. Using a soft handle for ease of use.
6. Moving the handles forward in order to start the right side air compressor and moving the handles backward in order to start the left side air compressor (Figure 18).
7. Considering different holes in the rod aiming the air/bubble exhaust (Figure 19).
8. Designing a play tool which is a type of brain teasers that not only is exciting but also reinforces the muscles throwing the rings into the rods.
9. Universality and simplicity in its function to cause cost reduction.
10. Using slopes part to guide the rings.
11. Holding a spiral lever in the lower section of floating chamber to show the start time of other children (Figure 20).
12. Flexibility in play tool to make it attractive.
13. Adjustable height of the play tool to make it safe and convenient.
14. Considering the objects dimensional modification to use both sides of the tool.
15. Reversible the mechanisms and movements.
16. Dynamizing the playground equipment.



**Figure 17** Merging two plans.



**Figure 18** Handle device Play.



**Figure 19** Holes for Air exhaust.

17. Interference of several senses in same playground equipment (touch, hearing, vision).
18. Coordinating the child's eyes and hands.
19. Exciting the playground equipment by creating bubbles in the ring chamber.
20. Using a musical space, attractive material and various colors.
21. Considering multiple air compressors in the play group to increase cooperation between children.
22. Using the deionized water to save the transparency of the chamber and stop any unwanted germ.
23. Using cheap, firm and non-toxic material for its base and its transparent part (such as polypropylene and polystyrene).



**Figure 20** Performance of bottom plate in the device play.



**Figure 21** Right view.



**Figure 22** A) Top view B) Side view C) Front View.

Figure 21 and Figure 22 show schematic images of playground equipment designed in this study. The designed play tool includes a pedal to move the mechanism. When the pedal is moving by hands the playground equipment is started in the upper chamber.

Also, some conic needle and some floating rings in the water adopted in the chamber. When the pedal starts to spin, some bubbles of air appears in the chamber and pushes the rings to move.

When the pedal is turning after 10 minutes the indoor plate is moving up vertically to reach the end of its path. That means the time of play is over for the first child and the second one can start the playground equipment. The winner is the child who matches the numbers of rings and needles more than other children. This playground equipment reminds the parents their childhood playground equipment so they may interest to participate in the playground equipment. Also, this equipment can be used by disabled and healthy children in one common game, so they interact each other. This interaction effectively helps the disabled to avoid of mental suffering.

### **Discussion**

In this research, a creative approach was adopted to design a playground equipment systematically. Also, the method introduced reduces the time needed by decreasing the trial and error efforts. Actually, the method based on combination of TRIZ algorithm and universal design is a new method of thinking to grow skills of designers. The final design does not address disadvantage of usual types of design which are using ineffective communication between healthy and disabled children. Therefore, the established method can be used to design a comprehensive tool aiming to have simultaneous play for different users.

In this research, the content validity was used to measure the validity of the result. Therefore, a questionnaire was used to evaluate the final playground equipment designed. The questions extracted from literature by reviewing the research background and research theories. The questionnaire includes 28 questions. The reliability of this questionnaire has been approved by experts. Then the questionnaire was filled in by experts and parents. In order to prove the validity of the fill out questionnaire Cronbach's alpha was used. Cronbach's alpha determined was about 0.955 that indicates the reliability of the test.

### **Conclusion**

In this research, algorithm of TRIZ, as a powerful method to design a play tool for children, was used in combination of universal design. For this purpose, initially play tool design was started using the technique of ISQ which is a subset of TRIZ algorithm and ideal solution method was utilized to support the results obtained from ISQ. Then using 40 inventive principles the final plan was designed. Throughout these processes the 7 universal design principles have been used. TRIZ algorithm make shorter the time of design compare to normal design because the algorithm of TRIZ has been organized in a way to decrease the trial and error efforts. A questionnaire was used in order to get reliability of the research. This questionnaire evaluated and answered by some experts. Consequently, it had been approved by them. Also, validity has been approved on the basis of experts' approach method. The questionnaire reliability was determined using Cronbach's alpha. The result shows that the Cronbach's alpha is about 0.955 which proves the reliability of test. The final design is based on a method which can be used to grow the skills of designers to make time of design shorter and increase the efficiency of design based on a systematic manner. For future study, it is suggested to carry out following researches using mentioned techniques.

1. Designing playground equipment for a verity of disabled children (The blind, the deaf, autism...).
2. Designing playground equipment to interact between children and parents.

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