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Designing a Multi-Color Display Adhesive Thermometer Based on the TRIZ Systematic Innovation Method

Youn-Jan Lin

Institute of Management, Minghsin University of Science and Technology

Hsinchu, Taiwan, R.O.C. Tel: +886 3 5593142ex3593

*Corresponding author, E-mail: yjlin@must.edu.tw

Abstract

The electronic thermometer model presented in this paper has two unique features, first it is easily attachable to a spot and second it provides a continuous readout of temperature by a method combining visual and digital signals. It is derived from TRIZ Su-Field analysis and is termed a Multi-Color Display Adhesive Thermometer. It is mainly intended for use with sick children. It has been featured in many exhibitions, gained a Silver and two Gold Medals, and has been patented in the USA, China and the R.O.C. (Taiwan).

Keywords: Awards, Su-Field analysis, Continuous readout, Multi-Color Display Adhesive Thermometer.

1. Introduction

1.1 Motivation of the Research

Existing electronic thermometers (for instance the aforesaid three types) have a common flaw. They are unable to attach to the surface of a measured individual or article for showing the temperature at any time, only allowing single measurement of the temperature, where each use calls for a repeat of a like procedure (repeated resets, repeated approach of the measured target, and repeated holding of the thermometer). There is a demand for showing temperature at any moment, which can currently only be met by the sophisticated monitoring systems of some medical organizations, and all the aforesaid prior art electronic thermometers do not have this requirement available. Therefore, a thermometer of a novel structural combination absolutely needs to be invented to meet such usage. Note, the ability of the thermometer to stick to the measured individual for showing the body temperature at any time is most demanded by parents with young and small children. Young and small children will occasionally be sick, and this definitely requires some time (a couple of days) to rest for an earlier recovery. Currently, their parents attend to them day and night and must measure their temperature repeatedly to know if they are getting better. Such efforts by parents that have already looked after their sick children for a long time causes significant fatigue. The inventor deeply understood the suffering of the parents, motivating him to offer a thermometer that sticks to the measured individual, for showing the body temperature directly. Moreover, it can further show the temperature situation on the surface of the thermometer through a number and color generator, providing the caretaker with better control over the measured temperature. In the same measure, this thermometer can also be applied to the measured location of an article or a place once the temperature is demanded for observation at any time.

1.2 Field of the Invention

The present invention relates to thermometers which can attach to the surface of a measured individual or article for showing the temperature at any time

1.3 Description of Prior Art

As regards the drawbacks of the traditional mercury thermometers, electronic thermometers have gained in popularity because of the following well-known advantages: highly assured safety, short measuring time and handy viewing readout. Conventional electronic thermometers appear in various forms, for instance, a popularly seen electronic thermometer, where its front is provided with a sense unit, is placed in some part of the human body (mouth, armpit or anus) of the measured individual, to sense the temperature, and the sensed temperature is read from a display unit located outside the human body. Another electronic thermometer, also named an ear thermometer, has its cone-shaped sense unit inserted into the ear of the measured individual for sensing the temperature, and the readout is shown in its display unit. Aside from the aforementioned two electronic thermometers, there are many different types. For instance, for some organizations or places (kindergartens, schools or department stores) that are prone to contagious diseases, a forehead thermometer is used to aim at the forehead of someone entering to scan and read the body temperature within a short distance, enabling the identification of potential fevered persons of temperatures over 37.5°C, for further affirmation or elimination, the said infrared forehead thermometer is categorized as an electronic thermometer.

2. Literature Review of TRIZ Su-Field analysis model

Su-Field analysis is a modeling approach in TRIZ for analysis and innovation in product systems. Standards are the most effective method for providing a graphical model of a problem. Su-Field modeling of a technical system is performed in the operating zone, the area where the core of the problem exists (Clarke, 2005).

Su-Field analysis is a basic concept used to refer to a technical system and the process of assessing its completeness and effectiveness. Recognized as one of the most valuable contributions that TRIZ has to make, Su-Field analysis is used not only for modeling systems in simple graphics and identifying problems, but also for improving systems with standard solutions. A Su-field model can represent a system, a process or a subsystem. It can be constructed step by step by comparing a problem with a similar one in a corresponding category and applying the suggested solution. It is a process that makes problem-solving easy.

The model normally consists of two substances and a field, as shown in Figure 1. The term S2 represents an object that needs to be manipulated, and S1 represents a tool that acts upon S2. Either or both substances can be a simple, single component or a complicated, large system with many components, each of which can also be explained by individual Su-Field models. The field is the energy required that will enable the interaction. The states of substances can be in typical physical forms (e.g., gas, liquid and solid), interim forms or composite forms (e.g., aerosol, power, porous). Likewise, the field can refer to any one of a broad range of energy sources, be they mechanical, electrical, magnetic, gravitational, chemical, biological, thermal, acoustics, or optics.

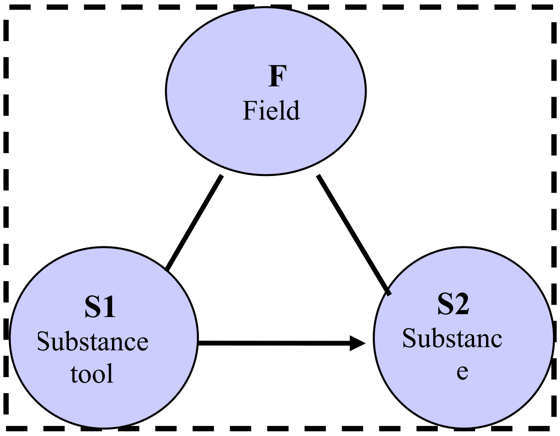

Fig.1. Basic Substances-Field Triangle Model

Genrich Altshuller and his colleagues, the creators of TRIZ, graphically represent a Su-Field model as a triangle. This is a simple and ingenious way to explain a technical system. Given the assumption the field is generated by a hidden substance, the triangle can be simplified into a dumbbell shape with the field indicated above the arrow and the relationship indicated beneath the arrow, as shown in Figure 2. There are four main types of relationship between the substances: useful impact, harmful impact, excessive impact, and insufficient impact. Among these relationships, useful and harmful interactions are the most common.

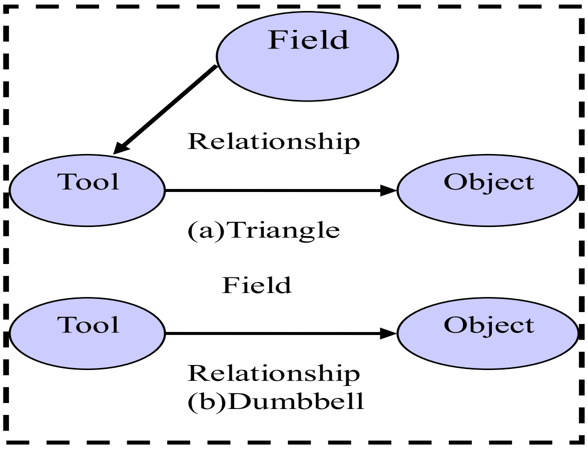

Fig.2. Basic Triangle and Dumbbell Su-Field Model

(Mao, et al 2007)

The Su-Field model is a fast and simple analytical tool for identifying problems in a system and for providing insights that help with the evolution of the system. Once a model is created, Su-Field analysis is used to determine if any of the three elements of the model is missing, or if there are any undesired effects in the system. Then, the analysis indicates the direction for improving the system. A complex system can be modeled using multiple, connected Su-Field models. Generally, there are four types of basic Su-Field models: (1) an effective complete system, (2) an incomplete system that requires completion or a new system, (3) a complete system that requires improvement to create or to enhance certain useful impacts and (4) a complete system that requires the elimination of some harmful or excessive impacts. (Terninko, 2000; Mao, et al 2007)

A series of articles began in the February 2000, issue of the TRIZ Journal, with a tutorial article about the Seventy-six Standard Solutions and the Class 1 problems and solutions. Class 2 appeared in the March, 2000, TRIZ Journal, Class 3 appeared in May, Class 4 in June, and Class 5 in July (Terninko, J., Domb, E., Miller, J. ,2000a; 2000b; 2000c; 2000d; 2000e). There are some applications in articles about the Seventy-six Standard Solutions (Shen, C.L.,2012; Chen, Y.Y.,2012; Hou, Y.H.,2012)

3. Innovative Concept for a Continuous Temperature Measured Device

3.1 Problem Description

Prior art electronic thermometers nowadays (for instance the aforesaid three types) have a common drawback, which is none can be attached to a spot on the body - or on an object - to give a continuous readout of temperature. What they all involve is an operation, a set of procedures, to measure a single moment's temperature. The procedural steps, repeated for each operation, are: set or reset the thermometer, place it on the required spot, hold it in place, and then inspect the readout.

3.2 Requirement Analysis

Note, the need for a thermometer that can be affixed to the body is one that is felt particularly important among parents caring for sick children. A period of care always includes the time the patient needs to recover and rest and the carer will want to monitor progress throughout by continuous temperature taking. The carer equipped to have continuous oversight of temperature has better control of a situation and can react accordingly as, for example, when deciding to treat a sudden rise in a child's temperature with antipyretics.

3.3 Function Analysis

The purpose of Function Analysis is to identify the key problems. The problem to be analysed, described in 3.1 and illustrated in Figure 3, is the thermometer cannot provide continuous readout of the temperature of a sick child. Thus, the function of the traditional thermometer, i.e., that is, the ability to measure and display temperature only at a single moment, is insufficient.

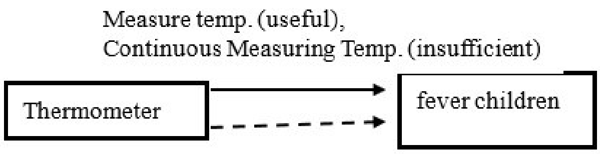

Fig.3. Function Analysis shows no traditional electronic thermometer can give a continuous readout of the temperature of a sick child

3.4 Applying Standard Inventive solutions

The algorithm for applying Standard Inventive Solutions is as follows: (Lin, Y.J., 2011; Ikovenko, S., 2010).

(1) Describe the key problem

Figure 3 shows no traditional electronic thermometer can give a continuous readout of a sick child's temperature, but only a measurement for a given moment. That moment, and each subsequent moment decided on, requires a set of measuring procedures (i.e., set or reset the thermometer, place it on the required spot, hold it in place, and then inspect the readout).

(2) Listing Interacting Components

In step 1, list all the substances and fields and the interactions relating to the problem. Then, the key problem is the existing electronic thermometer is not able to give a continuous readout of a sick child. There are two substances; the sick child and the thermometer. The field is thermal.

(3) Creating a Su-Field model

A Su-Field model of the engineering problem is created. Figure 4 illustrates the construction of a TRIZ Su-Field analysis model, which is based on Function Analysis. There are two substances in the model. The sick child is represented as an objective substance termed S2, and the thermometer as a tool substance termed S1. The thermal field, that is, the temperature of S2 (the sick child) delivered to S1 (the thermometer), is termed T. S1 detects S2 is insufficient information. Figure 4 depicts the model of the problem.

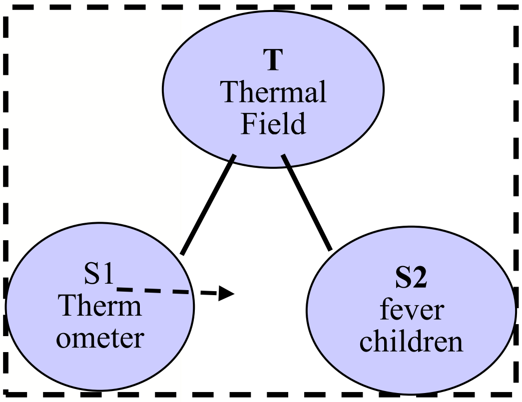

Fig.4. Model of problem for Situation in which Continuous Measuring of a Child's Temperature is lacking

(4) Solution in the model

Write the standard inventive solution applicable for solving the problem

As for the Standard Inventive Solution 4.5.1 of Su-Field analysis, the solution provided by the model is a transition to bi- and poly-systems. If a single measurement system does not give sufficient accuracy, use two or more measuring systems, or make multiple measurements.

(5) Creating a new Su-Field Model

This paper uses the method (i.e., Standard Inventive Solution 4.5.1 of Su-Field analysis) to introduce two new substances into the model and thus creates a new Su-Field Model of the engineering problem. The Standard inventive solution identified in step (4) is then applied. Introducing two New Substances, i.e, the "adhesive material" S3 and the "multi-color display" S4. With regard to the Standard Inventive Solution 4.5.1, Figure 5 shows the solution provided by the model is to introduce an external complex Su-Field. As a result of this introduction, S3 and S4, S1 and S2 are brought into continuous contact and multi-color display. Given the caring parents can continuously know the temperature of a sick child, they are better able to decide on treatment.

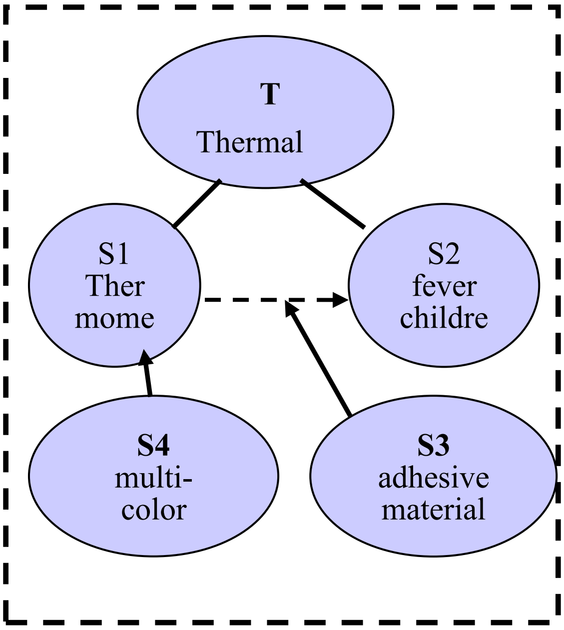

Fig.5. Model for Solution to Situation in which there is no Continuous Measuring about a child's Temperature.

(6) Describe the solution

The solution is described for implementing the created Su-Field Model.

The adhesive material makes it possible for the thermometer to be continuously attached to the sick child and for the display unit with number, color change to signal temperature changes as they occur. A Multi-Color Display Adhesive Thermometer was designed.

4. Present Achievements

4.1 Multi-Color Display Adhesive Thermometer Design

To achieve the foregoing objects of the present invention, the techniques adopted and the achievable functioning are described in detail with reference to the following preferred exemplified embodiments and the accompanying drawings, which help in thoroughly comprehending the present invention.

Figs. 6 and 7 illustrate the general picture of the Multi-Color Display Adhesive Thermometer, which comprises a three-part display unit, attachment unit and sensory unit [thermometer]. The display and sensory units are joined horizontally in the form of a rectangular parallelepiped with the display unit uppermost and face-up, along with a sound generator and a switch (in the preferred form of a thin-film switch). The sensory unit is lowermost and face-down. The area of the uppermost part is larger than that of the lower part, with the difference forming a rebated edge. The rebate allows the parallelepiped to sit in the opening of the flat pad by pressing to fit and that fit is helped by the edges of the opening having a covering of adhesive.

The surface that does the sensing is face-down on the part of the skin where it is affixed. When the power is switched on, the sensory unit measures the temperature and conveys the result to the display unit, signalling it in two ways. As can be seen in Fig. 6, the first signal is visual, given in digital form (e.g., 36℃, 37℃, 38℃, 39℃ or 40℃ --etc.) on the screen on the left while the second signal is a Multi-Color Display, provided by the status sound generator on the right.

This nature of the Multi-Color Display signal is designed to vary according to temperature. For instance, a temperature below 37℃ might be displayed by a green light, a temperature between 37℃ ~ 39℃ by a yellow light and a temperature over 39℃ by a red light.

The parallelepiped is brought into contact with and held in place at the desired spot by a holder, i.e., the flat adhesive pad. At its center, this pad has a rectangular opening, the edges of which have an adhesive covering. There is also an adhesive covering on the underside of the pad. The thickness of the lower part of the parallelepiped and the pad are roughly the same.

During assembly, the indented edge of the parallelepiped (the combined display and sensory units) is firmly press-fitted into the opening of the flat pad and the adhesive round the opening helps the close fit. The adhesive side of the pad, i.e., the down-facing side, is shielded by a temporary protective strip to prevent air contact. When ready for use, simply tear off the protective strip and attach the pad by its adhesive side to the desired spot on the skin of the patient, say to the forehead.

The protective strip can be either a single full-length one attached at one end of the flat pad or two half lengths attached one at each end of the pad, with an overlap in the middle. In the example illustrated here (Fig.7), the type of strip is two half lengths, but the full length, or even a strip divided in other ways, would serve the design just as well.

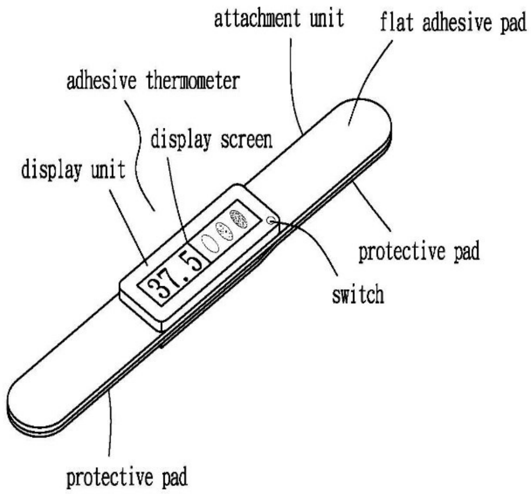

Fig.6. Exploded view of Multi-Color Display Adhesive Thermometer

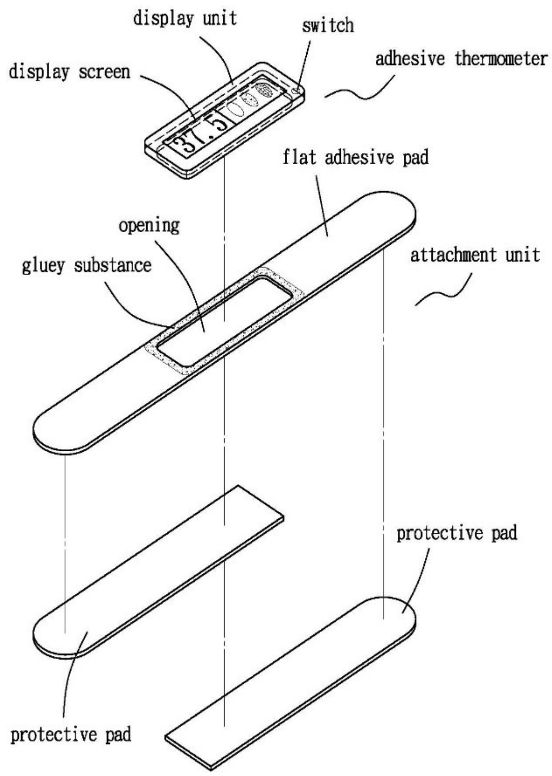

Fig.7. Decomposed view from Above of the Multi-Color Display Adhesive Thermometer

The combined display unit/sensory unit/attachment unit parallelepiped, shown in Figs. 7, is assembled at the factory stage, as shown in Fig 6, and wrapped and sealed airtight, ready for use. The parallelepiped is provided with electric power (e.g., by a thin battery cell) and an on/off switch to operate the units. The preference is for a somewhat concave switch to prevent unwanted contact with other surfaces.

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4.2 Awards

The device has featured in many exhibitions and has earned the following awards: 1. Silver Medal at the "2012 Moscow International Salon of inventions and innovation technologies" (Please see Figure 8). 2. Gold Medal at the "ANDI Invention Awards 2012". (Italian Exhibition of Inventions) (Please see Figure 9). 3. Gold Medal with mention at the "2011 5th International Warsaw Invention" (Please see Figure10).

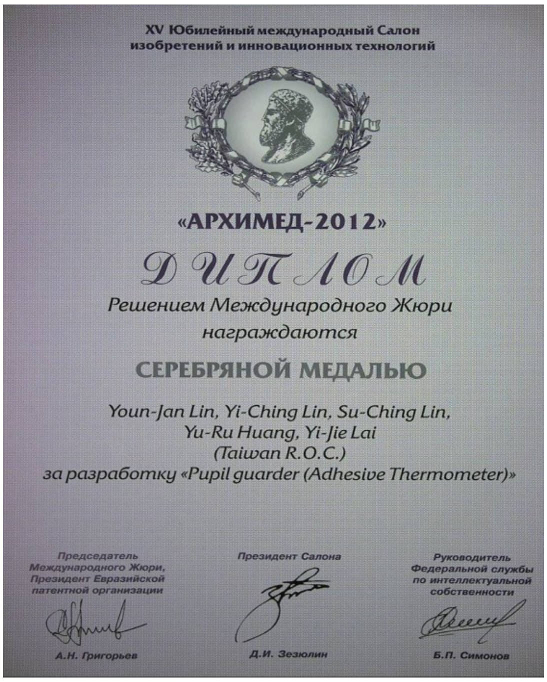

Fig. 8. "2012 Moscow International Salon of inventions and innovation technologies". Silver Medal Awarded

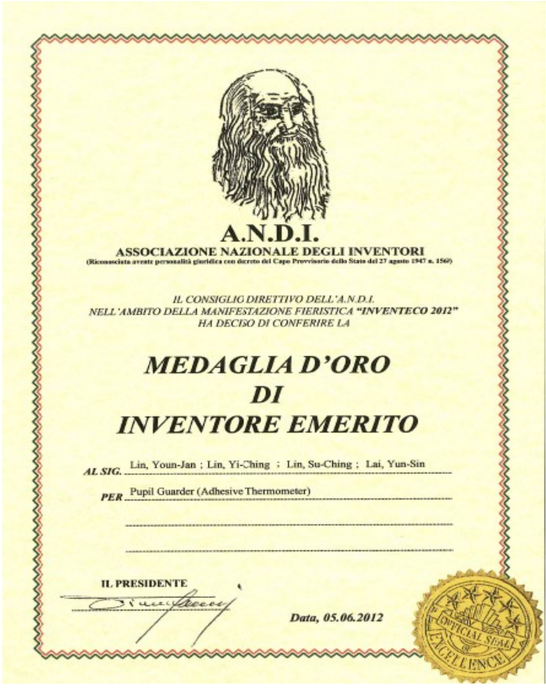

Fig. 9. "ANDI Invention Awards 2012". (Italian Exhibition of Inventions) Golden Medal Awarded

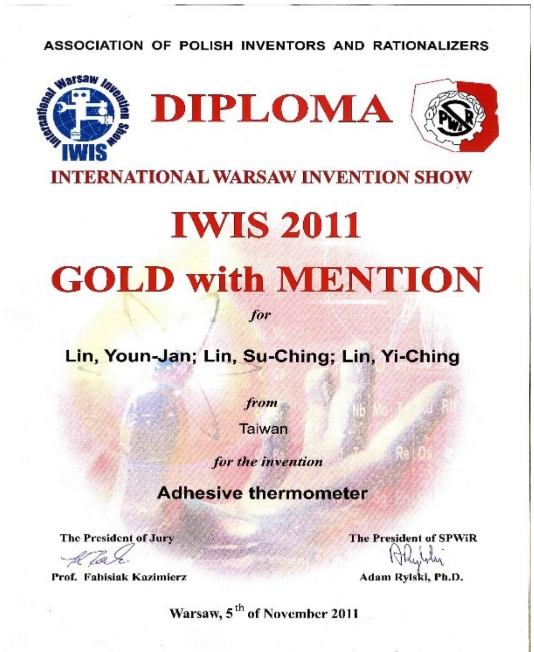

Fig. 10. "2011 5th International Warsaw Invention". Gold Awarded with me

5. Conclusions and Suggestions

Traditional electronic thermometers to date suffer a common drawback. It is not possible to apply them to a spot on a surface to be measured - be that to the skin of a person or the surface of an object – and obtain a continuous readout of temperature. The restriction is they can only give a moment –in-time readout, with each moment-in-time requiring a set of repetitive procedures. Young children will from time to time fall sick and require care at home – perhaps for days - by parents who might wish to take their temperature frequently.

In this study, the TRIZ Su-Field analysis model I construct has two substances. The sick child is represented by the objective substance termed S2, and the thermometer is represented by the tool substance termed S1. The thermal field, which is the temperature delivery from S2 to S1, is termed T. S1 continuously measures that S2 is providing insufficient information, and therefore the attached material S3 and multi-color display device S4 are introduced between S1 and S2. With S3, a continuous connection is made between S1 and S2 and with S4, a multi-color display is made between S1 and S2

Parents can know the temperature of their child at any time. Thus informed, the parents can treat the sick child accordingly.

For instance, a temperature below 37℃ might be displayed by a green light, a temperature between 37℃ ~ 39℃ by a yellow light, and a temperature over 39℃ by a red light.

This thermometer, an innovative design, integrates Su-Field analysis, Inventive Principles 32 color change.

The device consists of a multi-color display adhesive thermometer for affixing to a place on the skin of a person or the surface of some object to give a continuous readout of temperature in both digital and Multi-Color display forms. It comprises a sensory unit, a display unit and an attachment unit. The display and sensory units are joined horizontally to form a rectangular parallelepiped, the first on top of the second. The attachment unit consists of a sanitized adhesive pad which is the holder for the parallelepiped. The underside of the pad is covered with a temporary protective strip. In use, the protective strip is torn off and the pad is then applied to the desired location to sense the temperature. The display unit receives the temperature and signals it in two ways, by a visual signal (numerals) and an auditory signal (bleeps).

The display and sensory units may be safely reused within their lifetime, but the attachment unit must be disposed of after each use and replaced.

The invention has been patented under the name Adhesive Thermometer in the following jurisdictions: in the US as no. 8,061,891 B2; in The People's Republic of China as no. ZL 200810226181.4; in the R.O.C (Taiwan) as no. I377047. It has featured in many exhibitions and has gained a Silver and two Gold Medals.

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AUTHOR BIOGRAPHY

Youn-Jan Lin is a Professor of Ming Hsin University of Science & Technology(MUST) in Taiwan. He has taught in MUST since 1996.

He earned his PhD degree from the Department of Civil Engineering, National Taiwan University in 1995. He has licenses of PE in Hydraulic Engineering, Tour Leader of Chinese language, and etc. He is teaching in the Institute of Management. His areas of interests include Systematic Innovation including TRIZ, Green hotel, and Hot spring hotel. He received the “Greatest Teacher’s Award”, the highest honor recognizing the national most outstanding faculty from the Private Education Association in 2006. He got 46 patents and his inventive devices have featured in many exhibitions and has earned 45 awards, for example, as follows: 1. Most popular query prize at the “2006 Taipei International Invention Show and Technomart” in the National Science Council Exhibition Hall. 2. Golden Medal at the “2010 Moscow International Salon of inventions and innovation technologies”. 3. Gold Medal with mention at the “2011 5th International Warsaw Invention”. He was awarded “Lifetime Achievement of Invention” and “Pride of the Nation Inventor” that are co-awarded from Taiwan International Invention Award Winners Association and Golden State University of USA in 2009. He was one of Elastic Salary Prize Winner for Special Outstanding Talent in 2011 in the field of “Design, Cultural innovation, Hospitality and Leisure”, awarded by Ministry of Education.