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TRIZ Application on Fishing Pole with an Active Scent Release Lure

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(Received 7 May 2017; final version received 16 July 2019)

Abstract

To attract fish, fishermen generally use lures, which offer high catch rates and environmental friendliness. Fishermen who use lures must constantly move the line to make the lures move back and forth, stimulating fish attacks on the lures and increasing catch rates. However, each person can only fish with one pole at a time. This study uses the Theory of Inventive Problem Solving (TRIZ) to conduct a trend analysis of fishing lure improvement and construct a technical contradiction matrix, by using an active scent releasing device connected with a buoy lure. This device has a camera inside that uses scent as a fish attractant. The scent is released by a control button on the fishing pole. When fishing with this pole, fishermen can watch the screen attached to the fishing pole and observe the fish to decide the timing of scent release. This fishing pole with an active scent release lure can be effective in improving fishing performance. It is also different from traditional fishing methods in that one person can control more than one hand pole at a time.

Key words: culture and leisure fish farms, TRIZ, active scent release lures, buoy

1. Introduction

Taiwan is an island located in the subtropics, with numerous rivers and streams, a rich variety of fish, and many culture and leisure fish farms. Fishing is thus a traditional recreational activity. Taiwan society has become wealthier and more leisure oriented in recent years, and fishing has become more popular. At present there are roughly 200,000 recreational fishermen in Taiwan, 40% of whom fish in the sea, 55% in ponds, and 5% in streams, making it the third most popular leisure activity in Taiwan[1].

Most fisherman use lures, popular because of their high catch rates and environmental friendliness. However, because the lure is dead, the fisherman must manipulate the line to make the lure move back and force, since the lure is most effective when it imitates the movements of living bait. This research addresses the problem of developing a fishing pole with an active scent release lure that moves in a lifelike way but also releases an attractant. Using a trend analysis of a systematic approach to creating new technology, construction of a technical contradiction matrix and implementation of a function and attribute analysis, the dead lure is improved. In this research, the fishing pole is designed to trigger the scent releasing device with the attractant packed inside. Fish in the water will taste the scent and come to forage. Moreover, the fishing pole is equipped with a camera and screen which enables the fishermen to watch the fish, which helps to enhancing the entertainment in fishing as well as increase the fish catch rate, Further, one person can control more than one pole at the same time.

2. Literature Review

Traditionally many things are used as bait, from rice and leaves to worms and insects. Bait is not convenient, however. Hence, fishermen use lures, a form of artificial bait. Lures are moved by the fisherman, making it look like live bait to game fish. When the fish strikes, it is captured by the hook attached to the lure.

Rapala (1936) became the first to use thin pine boards to carve artificial minnow bodies, which he then wrapped in tin foil to give them a fishlike look, thus making the world's first lure[2]. Using lures, he then found that if the lure resembled live bait, game fish would strike. Because the lure had the function of live bait but was far more convenient and more environmentally friendly than live bait, they have steadily grown in popularity. Taiwan's largest lure maker, Strikepro, produces 400,000 lures annually, helping to make Taiwan an advanced maker of lures.

Fish have a sensitive receptor system (Butler, Field and Maruska, 2016). Olfactory and taste are the most critical senses. The fish's olfactory system is in the tip of the nose beneath the olfactory cortex (Kotrschal, 2000) and the taste sense of fish is located in its lips (Hamdani and Døving, 2007). Experienced fishermen spread scented bait across the water to draw fish. Fishermen often use starchy flours or other foods with fried flavors, and add a sticky material to make sticky bait. They then use the sticky bait on a hook or plaster the lure to stimulate the fish's sense of taste and smell. However, this technique can only be used with fish in shallow water. In deeper water or in rivers, the scent may disperse without effect. In this paper the authors

[1] Taiwan Fishing Right Organization http://1207834082401.tw66.com.tw/web/Blog?command=Intro, accessed on 2019/6/26.

develop a fishing pole with an active scent release device that increases the impact of scent in water and increases the catch rate.

The Theory of Inventive Problem Solving (TRIZ), from the Russian Teoriya Resheniya Izobreatatelskikh Zadatch) is a systematic approach to technology innovation. It was developed by the Russian inventor Genrich Altshuller and his colleagues beginning in 1946. They analyzed 200,000 patented inventions for pens and classified the innovations into different levels and types to create a systematic approach to innovation (Altshuller, 1996). TRIZ offers an innovation system for inventors to help them resolve technology innovation problems. First, the type of potential specific problems associated with the invention must be clarified. Based on the thinking of previous inventors in solving problems, through research and thinking of improvements, they classified problem solving approaches. TRIZ standardizes problem solving, enabling any problem to be treated as a standard problem. Key tools of TRIZ include: 40 inventing principles, 39 engineering elements, a contradiction matrix, and substance field analysis. TRIZ permits standardized problem approaches to converge on a particular solution. This enables to problem solving to break through the problems of individual experience, talent, and psychology that, when using traditional methods, may cause solutions to diverge.

This research uses the TRIZ convergence process structure of Mann (2002). It uses the convergence of evolutionary trends to view the current status of fishing lures. The trend predicts the future evolution of lures. This is paired with a function attribute analysis that performs similarity matching of the functions and attributes of lures, as well as improvement of lifeless lures or equipping them with the ability to move on their own. This process is shown in Figure 1 (Mann, 2002).

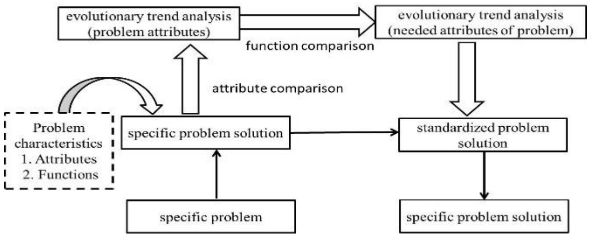

Fig. 1 The TRIZ process of evolutionary trend and function attribute analysis used in this research.

3. Considerations in Enhancing Lure Effectiveness

In order to enhance the lure’s ability to move and attract game fish, this research considers two technology levels. First, it examines the evolutionary trends of bait. It then explores the future evolution of lures. Second, it uses the technical contradiction innovation principles to identify the elements the fishing pole needs and find the best design for an active scent release function.

3.1 Evolutionary trend

Every technological system moves along a predictable evolutionary path, known as its evolutionary trend or line of evolution. The concept of similar technology types that repeatedly appear across different fields can be useful in predicting the development of technology. Mann (2002) divided evolutionary trend analysis into three categories comprising 31 items in total. The first category is time and contains six items: Action Co-ordination, Rhythm Co-ordination, Non-Linearities, Mono-Bi-Poly (Similar), Mono-Bi-Poly (Various), and Mono-Bi-Poly (Increasing difference). The second category is space and consists of 12 items: Smart Materials, Space Segmentation, Surface Segmentation, Object Segmentation, Evolution Macro to Nano Scale, Webs and Fiber, Decreasing Density, Increasing Asymmetry, Boundary Breakdown, Geometric Evolution(linear), Geometric Evolution (volumetric), and Dynamization. The third category, interface, consists of 13 items: Reduced Damping, Increased use of Senses, Increasing Use of Colour, Increasing Transparency, Customer Purchase Focus, Market Evolution, Design Point, Degree of Freedom, Trimming, Controllability, Reducing Human Involvement, Design Methodology, and Reducing Number of Energy Conversions (Mann, 2002).

The authors found that fisherman using traditional live bait used worms, flies, and maggots, which was more effective in attracting game fish than dead bait such as leaves, rice, and food. Anglers using lures used lifeless lures that they had to constantly move back and forth to make them resemble fish, forcing them to continuously operate the reel. Long periods spent moving lures can cause fatigue. Consequently, it is expected that in the future lifeless lures will evolve toward active lures that can induce game fish to strike. Of the 31 items reviewed in this research, 5 evolutionary trends were found to be associated with the evolution of lures: Mono-Bi-Poly (Various), Smart Materials, Dynamization, Increasing Use of Color and Reducing Human Involvement.

The first of the five aspects of the evolution of bait, Mono-Bi-Poly (Various). There are four stages in carrying out the evolution of this item: Single system, dual system, three systems, and multi system. At present in the aspect of Mono-Bi-Poly (Various), lures have evolved to increase the elements and functions of the system. The next step is three systems. The second evolutionary aspect is Smart Materials, consisting of four stages: Passive material, One-way adaptive material, Two-way adaptive material, and Fully adaptive material. Currently lures are in the Two-way adaptive material stage moving toward the next stage of Fully adaptive material. The third evolutionary aspect is Dynamization, which has five stages: Immobile system, Jointed system, Fully flexible system, Fluid or pneumatic system, and Field based system. Currently lures have reached the stage of Jointed system, with the next being Fully Flexible system. The fourth evolutionary aspect is Increasing use of color. It has four stages: Monochrome, Binary use of colour, Use of visible spectrum, and Full spectrum use of colour. At present lures have evolved to look like fish and are in the Use of visible spectrum stage, evolving toward Full spectrum use of colour. The fifth evolutionary aspect, Reducing Human Involvement has six stages: Human, Human with tool, Human with powered tool, Human with semi-automated tool, Human with automated tool, and Automated tool. At present in the aspect of Reducing Human Involvement, lures have evolved to the Human with semi-automated tool stage.

Figure 2 shows that Mono-Bi-Poly (Various) are evolving toward increasing the number of elements and functions of the system. Smart Materials are evolving in the direction of fully adaptive materials. In Dynamization, baits are evolving in the direction of fully flexible multiple connection systems. In Increasing use of color, they are evolving to use the full spectrum of color, just as a real fish does. Reducing human involvement is moving in the direction of reducing human fatigue. Thus, the future development of lures will move toward reduced use of human operation, dynamic ability to move as a fish does and release scent in the water, and colors and materials that closely resemble those of a real fish, making it more effective in enticing game fish to strike. The current evolution of lures is shown in Figure 3.

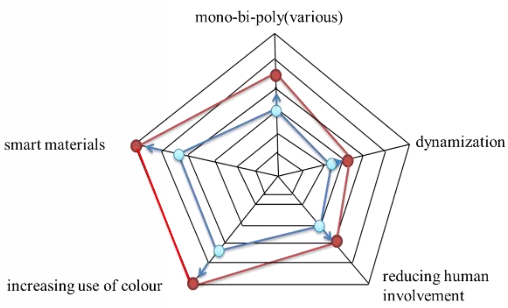

Fig. 2 The five aspects of lures evolution potential on red circle presents on blue circle

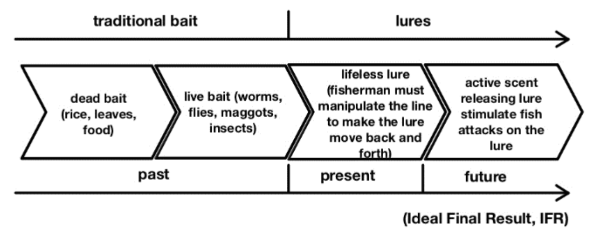

Fig. 3 Evolutionary trends of lures

3.2 Technical Contradiction

This research explores the lifeless lures currently used by fisherman, that require the fisherman to continuously move them. For a lure, swimming like a real fish represents a dynamic function. Thus, the parameters that must be improved in this system should not reduce the lure's ability to function at different depths and in different water layers without outside assistance, force, and management of the time fish are caught by bait. This represents the technical contradiction problem (Hsia, Huang, and Chen, 2011; Bukhman, 2012). The 39 engineering parameters are used to solve technical contradictions (Yang and Chen, 2011). When the features of the system's contradictions are known, the items that should be improved include Item 10, Force, Item 35, Adaptibility and Item 37, Complexity of Control. Parameters that should not be worsened include Item 13, Stability of object, because the lure needs to be stable in the water, and Item 14, Strength, because the lure must be strong in order to move in the water like a lure on a fishing line. These problems are used to construct the technical contradiction matrix, as shown in Table 1. Based on the technical contradiction matrix shown in Table 1, 15 inventive principles can be used: 35, 10, 21, 30, 14, 11, 22, 39, 27, 3, 32, 6, 15, and 28.

Table 1 Technical Contradiction Matrix

Parameters that must be improved \ Parameters that should not be worsened		Stability of Object	Strength
		Item 13	Item 14
Force	Item 10	35 10 21	35 10 14 27 15
Adaptability	Item 35	35 30 14	35 3 32 6
Complexity of Control	Item 37	11 22 39 30	27 3 15 28

Among the 15 inventive principles, to enable the lure to swim like a fish without outside assistance, the necessary elements were found to include the six inventive principles: 15, 22, 10, 11, 30, 3, 32 and 27. The remaining six did not appear to have any clear effect on improvement of the lure and were not used.

Inventive principle 15, Dynamics, states that in order to adjust the object or its environmental performance and enable all stages of work to achieve optimal performance, the object should be divided into parts capable of movement relative to each other. If an object (or process) is rigid or inflexible, it should be made movable or adaptive. To use these principles to resolve the problems found, the lure must be equipped either internally or externally with a propulsion unit to enable it to move without outside assistance.

Inventive principle 22, Blessing in disguise, states that harmful factors (especially harmful environmental effects) can lead to beneficial consequences. For example, one harmful factor may be combined with another to eliminate the negative effects of either or both, or a harmful factor may be increased to such a degree that it is no longer harmful. Using this principle to find solutions for problems indicates that a water battery should be used to provide propulsion. This is more economical and does not cause water pollution like an ordinary battery since it uses contact with water to generate electricity.

Inventive principle 10, Preliminary action, states that required changes to the object (whole or in part) must be implemented before they are needed. Objects should be pre-positioned in the most convenient location, enabling them to be used without loss of time. Using this principle to find solutions for the problem shows that control board must be built into the lure in order to enable to simulate the swimming motion of a fish.

Inventive Principle 11, Beforehand cushioning, states that emergency measures must be prepared in advance to compensate for the relatively low reliability of an object. This principle is used to solve the problem. For the buoy shell design, the propulsion unit is matched with a buoy shell, and the lure is connected with the buoy. When the propulsion unit is running, the lures will swirl.

Inventive principle 30, Flexible shells and thin films, states that flexible shells and thin films should be used instead of three dimensional structures. Using this principle to solve the problem, flexible shells and thin films are used to enhance the floatability via an inflatable buoy shell.

Inventive principle 3, Local quality, states that an object's structure can be changed from uniform to non-uniform, or an external environment or influence may be changed from uniform to non-uniform. Each of the object's parts should be made to function in the conditions most suitable for its operation, and each part should fulfill a different and useful function. Gunzo and Toshihisa (2002) found that the catch rate was highest when the lure was red, or black, followed by yellow, green, orange, and pink [11]. Using this principle to solve the problem, the exterior of the lure should be a color that is attractive to game fish, and the lure should resemble a fish in appearance to the extent possible.

Inventive principle 27, Cheap short-lived objects, means replacing an inexpensive object with a multitude of inexpensive objects, comprising certain qualities. Lures under water can release the scent, so it is necessary to install a device which is designed with an inner and outer feeder can. The inner can is filled with the scent bait, while the outer can includes the compressor and camera lens. The compressor consists of a battery, motor, and spring. When the fishermen pushes a button on the fishing pole, the feeder outer can extrudes the feeder inner can and the compressor scent is emitted immediately from scent feeding hole to attract fish as shown in Figure 4.

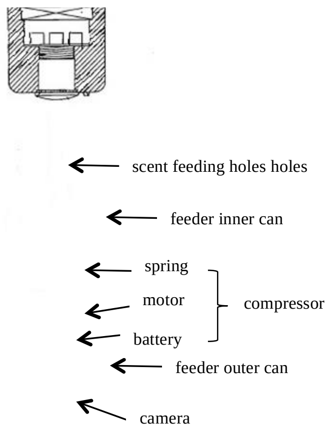

Fig. 4 Active scent release device

Inventive principle 6, Universality, Make a part or object perform multiple functions. A camera is installed at the bottom of the active scent releasing device and connected to a screen on the fishing pole. The fisherman can observe the fish and decide whether to trigger the scent release control button on the fishing pole.

The technical contradiction matrix shows that to make a lifeless lure into a lure that simulates the movements of a fish and releases scent, at least 6 components should be added to the lure, and its color should be changed. These five items include: (1) a water battery; (2) control board; (3) propulsion unit; (4) inflatable buoy shell; (5) active scent release device; and (6) a screen. The screen installed on the fishing pole is not an underwater component. The authors next perform a function attribute analysis of the underwater components. Through examination of their cause and effect relationships, the authors identify the optimal design for the active scent release lures.

4. Function attribute analysis

Function attribute analysis (FAA) examines system and subsystem components to identify relationships between components and assemblies, as well as the components of main and subsidiary functions. The purpose of this analysis is to determine which functions and relationships exceed, are insufficient, or harm system functioning. Such functions are termed negative functions. Using the relationships between negative functions and each component, points of contradiction of problems may be identified and used to resolve the problems.

This study investigated the active scent releasing device using function attribute analysis. It draws a border around the causal chain of the function attributes. The causal chain shows the cause and effect relationships between the 6 components. Function attribute analysis is then performed. As shown in Figure 5, the water battery adds weight, which must be prevented from affecting the swimming motion of the lure. Consequently, an inflatable bag must be added to enhance its ability to float and move in the water. As a result, the water battery, and inflatable bag are excessive functions. The water battery merely drives the propulsion unit, and both are insufficient functions. A control board is necessary to control the operation of the two propulsion units in order to enable the propulsion unit to operate when water is flowing through the lure, intake and release differing amounts of water, and simulate the movements of a fish. Because of this, the propulsion unit and the water pipe are useful functions. Since the tool is attached to the inflatable bag body, the inflatable bag body has useful functions. To maintain the lure’s ability to swim, all components must balance each other. Because the water battery is heavy, it is necessary to place it at a location where it balances the water pipe. Consequently, their relationship is harmful. Since water goes in and out of the pipe, it will make the lure unstable. Further, the battery, water pipe, and propulsion unit must be balanced. Thus, using stabilizer fins and an inflatable bag to enable the lure to stably produce the swimming motion of a fish requires overcoming the harmful function of the water pipe, water battery, and inflatable bag.

Additionally, the lure’s color must be one that is attractive to fish, such as red or black, mimicking a real fish, to give it a higher catch rate.

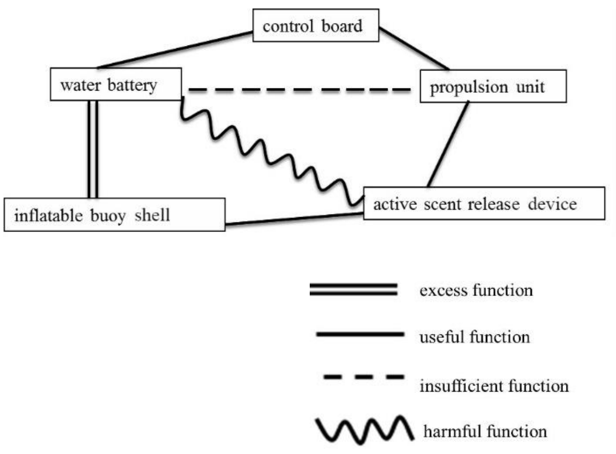

Fig. 5 Lure Component Function Attribute analysis

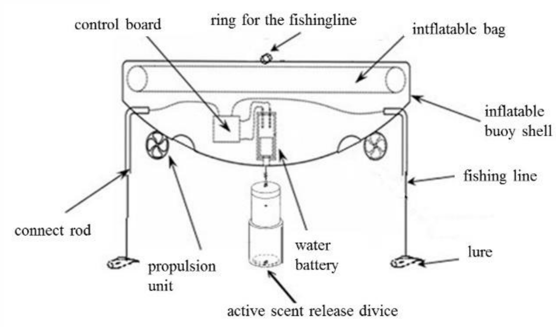

Fig. 6 An active scent release device connected to the inflatable buoy shell

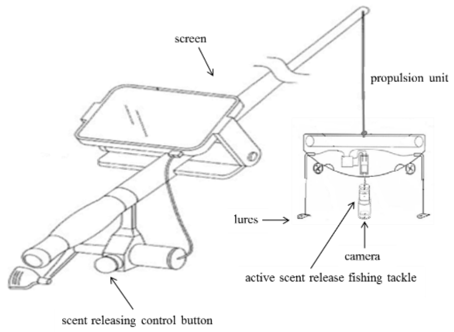

Fig. 7 An active scent release device connected to the inflatable buoy shell

5. Design of the fishing pole with an active scent release lure

Through the analysis of evolutionary trends, technical contradiction matrix and functional attribute analysis, the authors develop a fishing pole with an active scent release lure. The design principles for this fishing pole are discussed below.

An active scent release device with a real fish-like dynamic swimming function can adapt to the fishing pole with an inflatable buoy shell in the water. The battery is fixed in the center of the buoy. The control circuit is placed next to the buoy and filled with the inflatable balloon, which helps to maintain the stability of the reciprocating operation. In addition, the camera signal lens is installed at the bottom of the active scent releasing device, and the signal line is connected to the screen at the front end of the fishing pole. When the battery is activated, the propulsion unit turns on and the bait is operated as a swimming fish, as shown in Figure 6. Fishermen can watch the activities of fish under the water and decide whether to release scent bait, as shown in Figure 7.

Since the camera enables underwater observation of the lure and nearby fish, fishing may become more entertaining. Moreover, this innovation changes the traditional way of fishing. Using our fishing pole, a fisherman can control several hand poles at the same time.

6. Conclusion

In this study, TRIZ is applied to develop an active scent release lure which can swim actively in the water. First, the authors performed an evolutionary trend analysis in order to determine the future path of lure development. This found that lures are moving toward active lures that embody reduced user operation, and increased ability to move like a fish. Materials are moving toward becoming as soft and colorful as an actual fish. Second, a technical contradiction matrix was used to identify functions to enable the active lure to simulate a fish. The six components are: (1) a water battery; (2) control board; (3) propulsion unit; (4) inflatable buoy shell; (5) active scent release device; and (6) a screen. The design of these six components can make the bait appear to be real swimming fish. Third, a function attribute analysis was performed. This found that the buoy shell can carry lures that dangle beneath a buoy.

This design enables the lure to simulate the movements of a fish. Fishermen, using the camera and the screen, can watch fish to determine the timing of the scent release. Using this innovation, fishing can become a more entertaining leisure activity, with increased catch rates since one person can control more than one pole at same time. Along with the improvement of technology by time on time, the volume and weight of the active scent release lure can be reduced, and become for the fishing operations in the fishery production.

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