Enhanced Helipad Design for Safety Redundancy by Using Systematic Innovations

George A. dela Cruz and Song-Kyoo Kim

***Abstract*—One of the challenges of flying modestly equipped helicopters is when circumstances warrant that pilots had to fly night visual flight rules or Night VFR which are the rules under which flight are primarily by visual reference done at night. The problem is further aggravated when the helicopter had to land in a modestly equipped facility with a busted landing light or the pilot is disoriented that he doubts his visual references because it is worsened by limited illumination. How can ground controllers innovate their modest resources to help pilots know wind direction and glide slope especially at night? This paper attempts to find simple and inexpensive solutions to help pilots make flying as safe as possible especially during unforeseen circumstances.**

***Index Terms*—Helicopter safety, night VFR, precision approach path indicator, systematic innovation.**

I. Introduction

Human factor remains as the major cause of aircraft accident with 85% of the crashes attributed to it even though the probability of a crash is almost marginal at 1 in 8,000,000. On the other hand however, helicopter crashes are higher than in airline because of inherent disparity in terms of aircraft operations. A helicopter lands in a different area almost every flight airliners and other fixed wing aircraft, which always land on established airport or aerodromes. It is also important to point out that 80% of the crashes occur during takeoff and landing. These are the moments when your aircraft capabilities are tested. You need power for take off in the same manner that you need it as well in landing if in case the aircraft has to make a go –around in case of a missed approach.

The objective of this project proposal is to find out if similar technology that is being used by fixed wing aircraft landing in airports can be adopted using limited resources available. The reason is that there are times when helicopter pilots had to fly after dusk because of some exigencies that cannot be prevented. Usually, daytime operations end half an hour prior to sunset. Helicopters which are especially equipped to carry out night flying with special avionics or those equipped and trained to use night vision goggles can proceed and continue night time missions. The objective of adopting technologies found in airports and incorporating it to a helipad, be it located in a building or in remote locations using cheap and inexpensive substitute, is to make safety redundant. This means that pilots will not be having a hard time landing their aircraft even if they encounter an emergency. Landing, when there is limited illumination, is a challenge especially to a neophyte pilot who is just gaining his flying time. Landing lights are of course, very helpful but then there are instances when things do not go the way it should go. Such situation is nerve-wracking and ideally, should not be experienced even by veteran pilots because it would mean that he will gamble on safety. The overarching goal of every organization engage in air transport whether fixed wing or helicopter, is to make flight safety multilayered in such a way that pilots will accomplish their goals without putting at risk the life of passengers and other air crew.

II. Problems of Helipad Safety

The team looked into the possibility of adopting similar technology that can be found at airports that guide the pilots on approach to landing. At present, airports use Precision Approach Path Indicator (henceforth PAPI) to guide pilots while landing. PAPI is a "visual reference that provides guidance information to help a pilot acquire and maintain the correct approach (in the vertical plane) to an aerodrome or an airport [1]. It is generally located beside the runway approximately 300 meters beyond the landing threshold of the runway." The following figure shows what it looks like prior to landing inside the cockpit of an aircraft:

Fig. 1. The scene from inside of an aircraft.

PAPI lights indicate whether you are too high, too low or on the correct glide path. The implication prior too landing is that when you are above the glide path, the aircraft will overshoot the runway. On the other hand, if you are too low, the tendency of the aircraft is to undershoot the threshold [1].

The goal of a pilot is to achieve correct attitude for landing and land right after the threshold markings. Based on the foregoing illustration you should land after the marking "20." "20" is the runway orientation based on magnetic azimuth.

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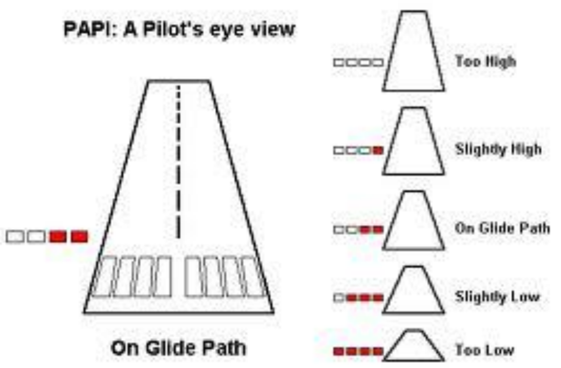


Fig. 2. Indication of runway of aircraft.

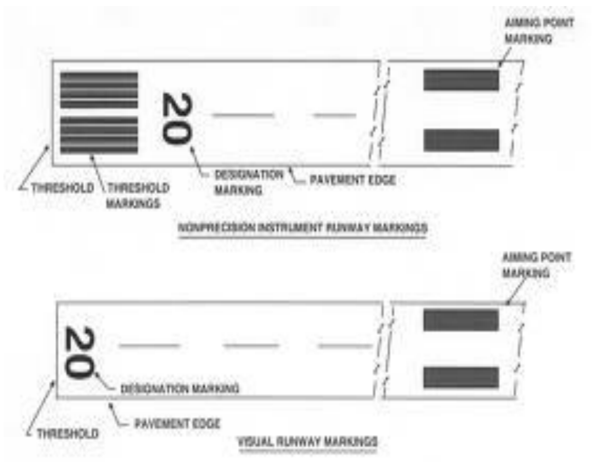


Fig. 3. Illustration of the runway threshold.

III. Systematic Innovation

Systematic innovation [2] is a structured process and set of practical tools anyone can use to create (or improve) products, process or services that deliver new value to customers. It is also a set of continuous evolving tools that will improve ability to solve the problems. TRIZ [3], [4] is the most powerful methods for systematic innovation methodologies. The substance-field model [5], [6] and 76 Inventive Standard [7]-[9] were conceptualized by the founding father of TRIZ, Genrich Altshuller [10]-[12]. The Standard Solutions are grouped by constraints, so they can help the specialists find appropriate solution concepts [12].

A. Problem Identifications

To analyze the problem more clearly, ENV model, Function Model and Root Cause Analysis (RCA) are applied. Based on ENV model, the problem can defined as follow:

Problems:

- Element: Helicopter helipad
- Name of Feature: platform for landing
- Value: no special lighting for safer landing
- Element: Pilot
- Name of Feature: flies the helicopter
- Value: limited visual references at night

The next step applies the problem into Function Model (see the Fig. 4.)

The function model (see the Fig. 4) reveals two contradictions. At night, the tendency of the pilot is to rely mostly in his instruments to check if all systems are within normal operating limits. This however, limits his ability to look at visual references outside especially during landing unless the helicopter is equipped with special equipment or night vision equipment which makes night time flying seems like day time. But with limited capability, the pilot will rely heavily on his instrument and outside visual reference if it is available. If it is not then, the risk will be high especially when the landing lights fail as well or the air crew is not confident in flying at night because of lack of training. Based on the function analysis (or function model), the problem can be defined as follow based on ENV model.

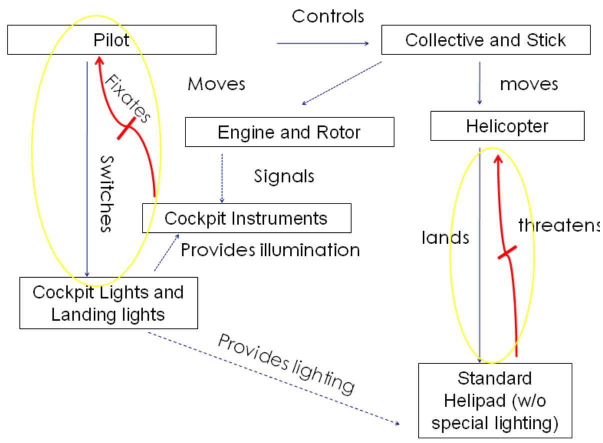


Fig. 4. Function model of the problem.

ELEMENT	NAME OF FEATURE	CURRENT VALUE	DESIRED VALUE
COCKPIT INSTRUMENTS	PROVIDES INFORMATION	BAD LANDING(FIXATES ATTENTION)	GOOD LANDING
HELIPAD	LANDS HELICOPTER	LESS SAFE	MORE SAFE

Fig. 5. ENV model.

In the other hand, RCA (Root Cause Analysis) is designed to find the core problem from the original problem. The expanded RCA would reveal other problems. These, among others, include lack of budget to fund project, bad safety program, not enough visual reference and pilot inexperience. The solution should answer the core problems of funding requirement; pilot inexperience, difficult working conditions and space (see the Fig. 5 and Fig. 6.)

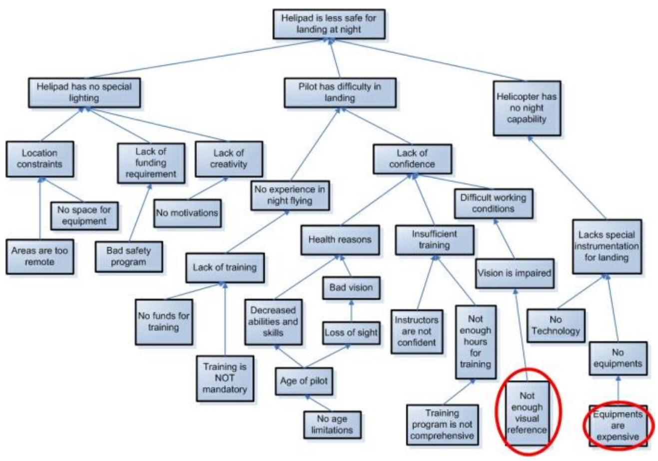


Fig. 6. Root cause analysis I: full analysis.

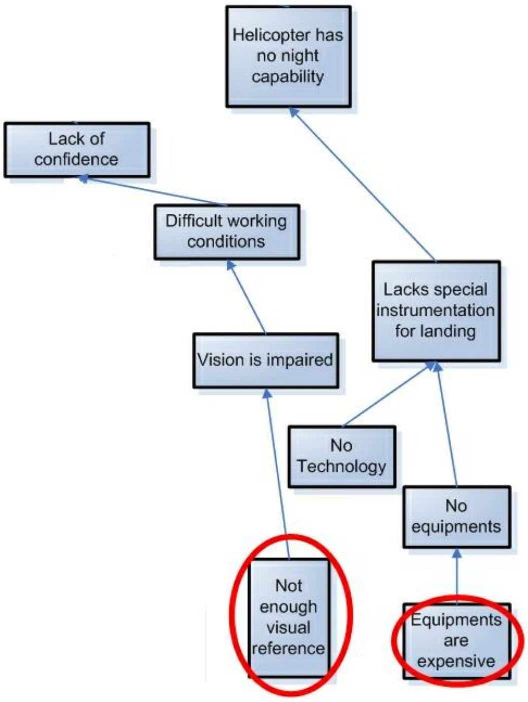


Fig. 7. Root cause analysis II: problem parts.

B. *Problem Solving by Inventive Principles*

TRIZ defines a set of 40 inventive principles and 39 system features that one typically wants to improve. The system that has the technical contradiction can be clarified based on the feature for improve and the feature for remove within a set of system features [12]. Originally, Altshuller reviewed patents in order to find out what kind of contradictions were resolved or dissolved by benchmark the patents that had been achieved.

The contradiction of the system is that during circumstances when there is limited illumination (NIGHT FLYING), the pilot will have difficulty in landing the helicopter. If we will not improve the helipad then safety of pilots and passengers are compromised. Safety must be redundant. To solve this contradiction, Versatile, durable and energy-efficient source of lighting that can be incorporated to the helipad as parts of resources. The core problem is defined from the previous session is that space, pilot inexperience and difficult working conditions. This will also answer the contradictions as revealed in the Functional Model leading to safer landing for pilots through safer helipads equipped with special, inexpensive lighting.

The technical parameters and the recommendations from the contradiction matrix from Altshuller [12] are:

Improving Feature: reliability of the helipad (#31)

Worsening Features: generating armful factor (#27)

Responding Inventive Principles:

- No. 35: Parameter change,
- No. 2: Extraction,
- No. 40: Composite materials,
- No. 26: Cheap and inexpensive copy

The Inventive Principle number 26 is chosen to remove the harmful effects and incorporate the current technology to make the helipad safer for landing.

IV. Concept Design for Helipad Safety

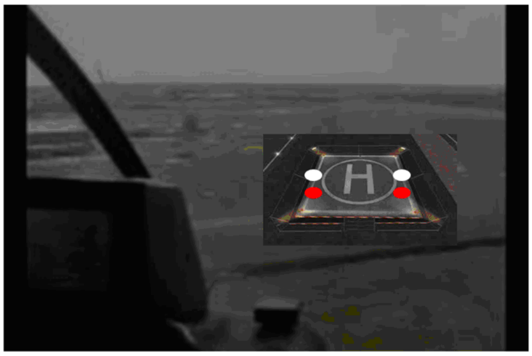
Based on Inventive Principle 26 in Systematic Innovation Method from the previous session, the subsequent concept design is proposed as follow:

Fig. 8. Concept design of guide slope.

Energy –efficient LED lighting will be used so that the system can still function even when there is no electricity since you can use other means as source of power such as car batteries.

The system will be connected as well to the wind cone and weather vane in order to determine wind direction plus correct landing spot. At correct altitude, the pilots should be able to see the LED lighting which is positioned at 30 degrees with respect to the pilot's point of view. The condition is for pilots to see all four lights to know that he is in correct glide slope for landing. If he partially sees the lighting system then this signals that he is not correctly approaching the helipad and may need to adjust his flight path (see Fig. 8).

Fig. 9 shows how the system will look like prior to landing when all parameters have been met by the pilot:



PILOTS WILL KNOW THAT THEY ARE IN CORRECT GLIDE SLOPE
WHEN THEY SEE ALL FOUR LIGHTS

Fig. 9. Concept design of guide slope.

The recommended redesign of helipad is conceived to ensure that veteran and neophyte flier will be able to land at any time of the day especially at night.

V. Conclusions

There are so many problems in the world that we can solve if people will be creative and passionate enough to make a dent in the larger scheme of things. This we can do without the use of sophisticated and expensive materials in order to improve and enhance the characteristic of certain equipment which has always been a part of our everyday lives.

Aviation needs to have a multilayered safety feature which will make flying pleasurable, comfortable and more importantly safer for both pilots and passengers. Statistics show that there are 7.5 accidents per 100,000 flying hours compared to the marginal figure of only 0.175 accidents per 100,000 flying hours in fixed wing aircrafts. This is because helicopter is relatively complex vis-à-vis with its counterparts. It flies low which exposes it to so many hazards because of the various missions that it can perform. Helicopters can be used in so many ways such as firefighting, medical evacuation and law enforcement. The military uses it for combat and air mobility because it can land even in the least prepared landing areas. This is the reason why it is perceived less safe because of the myriad inherent risks involve when it flies. The recommended redesign of helipad is conceived to ensure that veteran and neophyte flier will be able to land at any time of the day especially at night. Although there is sophisticated equipment that can be added, complement the safety features developed by manufacturers for their respective flying machines is most important. After all, safety is paramount and it must be redundant.

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