A practical method of accurate troubleshooting mechanism in the decision objective teaching type on the integrated landing system

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Abstract. An aircraft is a transportation system that works in conditions according to the standards. When an aircraft technician is aware of a system failure or damage, he must make the right decision to overcome the problems that occur. A relatively high level of accuracy decision making based is a necessary treat. This condition must be anticipated in aircraft vocational education. An integrated landing system is one of the subsystems on an aircraft that requires quick and precise handling if there are problems. A practical method that accommodates various concepts in troubleshooting is proposed to facilitate aircraft technicians’ competence. This method performs standardization of troubleshooting steps in a particular algorithm so that it is more systematic. The appropriate validation and verification steps follow this troubleshooting mechanism to ensure that the system is up to standard.

1. Introduction
The current aerospace technology is developing rapidly. The aircraft is equipped with various supporting equipment that works manually or automatically even supported by a computer system. This high complexity will cause problems if not managed properly. The problem of accuracy and standardization is very crucial for aeroplanes, both in their use and maintenance. In vocational education, preparing skilled personnel who work to take care of aeroplanes with great accuracy and accuracy is a challenge that must be answered immediately. Things that have the potential to become obstacles when the process of transfer of knowledge from teachers to students related to aircraft should be reduced or even eliminated as much as possible. Precautions about the misallocation of problems and determining troubleshooting steps can be fatal to aircraft performance, and it must be conveyed to students. For this reason, certain teaching methods are needed to bring out students' wisdom and skills in overcoming problems on a plane. The decision approach for maintenance and repair strategies is a long-standing challenge in the avionics system. Error diagnosis and inadequate maintenance of avionics system equipment, complex and uncertain equipment error information make error determination and corrective steps difficult for flight vocational education students. The psychological factors of policymakers’ risk in the decision making and diagnosis process require special methods and approaches in teaching and learning avionics in general and aircraft landing systems in particular. The teaching process to help students are able to recognize problems and find solutions using certain strategies. Therefore the instructor uses performance-based teaching methods and decision objectives that will help students to make accurate and correct decisions in
troubleshooting. This method pays attention to various psychological and technical factors so that it will produce a coherent output. In this paper, we will explain the basic concepts of the teaching methods used in sub-chapter 1, then we proceed with some terminology and literature review about this teaching method and related work, especially aeroplanes in chapter 2. Chapter 3 will present about the methods proposed in this paper that exemplified in a subsystem on an aircraft that is an instrument landing system, especially those integrated with a computer system. This means that the method taught must be more specific than the instrument landing system which tends to be manual. Chapter 4 will explain the execution of the method proposed, and chapter 5 will close the research description.

2. Related Work

Jilianget al. [6] describe the general troubleshooting research and domain specific research. The difference is about the characteristic, the mechanism and the aim. The general trouble shooting concerns with knowledge, skills, and other characteristics of abstract systems and identification of diagnostic strategies troubleshooters used, while domain-specific research represents the real systems. Most of the mechanism is training-related. On the other hand troubleshooting skills research raise affecting performance. The skills that appear to produce good troubleshooting performance relates to ability to repair or replace system components, ability to diagnose the problem and to employ a strategy to search for the failure. Botello et al. [2] provide The Aircraft Maintenance Intuitive Troubleshooting (AMIT) program, which was conceived at the U.S. Air Force Research Laboratory's Human Effectiveness Directorate as a revolutionary step in providing domain-specific knowledge and information to those in aircraft troubleshooting roles.

2.1. Performance Base Teaching

Performance and decision base teaching are part of the Objective teaching method, respectively. Both complement and support each other to build a student's ability to make the right decisions when making repairs to aircraft damage. To make it easier it can be explained by using the diagram in Figure 1 below

![Objective Teaching Method Concept](image)

**Figure1.** Objective Teaching Method Concept.

Performance-based teaching is an approach to teaching that emphasizes on what the students are able to do, or perform, in the form of specific skills as a result of instruction. The students will be charged to show the ability to apply or use knowledge. The focus of this method is on how the content is taught and assessed. Conditions that may be encountered when there is damage on an aircraft are unstructured problems, uncertainties, large amounts of data or information, changing conditions, feedback loop conditions, regulatory problems and many others, all require certain methods to overcome them. Associated with this teaching method, students will be given an understanding of how to recognize abilities that must be interrelated with problems that arise. This is the first step before making a decision to repair the damage. After recognizing their abilities, students make analyzes and diagnoses of problems with specific systematics. Figure 2 illustrates the Performance base teaching in a simple way.
2.2. Decision Objective Teaching

After studying the problems that occur in aircraft, then steps will be taken to overcome them. For this reason, decision objective teaching methods are used that will help to make the right decision when solving problems. Matters related to the decision objective teaching method include cognitive abilities, affective and psychological conditions. In order to make the right decision, students are taught to have a holistic perspective of a problem. The concept of decision Objective Teaching is shown Figure 3.

Figure 3. Decision Objective Teaching.

Figure 3 shows the intersection among the system, information and practice that should be owned by students to enable them to make the right decision. The student’s behaviour, competency and knowledge are the outsiders that also determined the outcomes.

2.3 Instrument Landing System (ILS)

The instrument landing system is a sub-system of the flight instrument system which is related to all matters of aircraft landing. Students must know all matters related to the landing mechanism, supporting devices, supporting parties and also landing regulations so that if there are problems or failures in the landing can analyze from many points of view. Related to the landing process, the initial process that must be known is the weather during the landing because it will affect the performance of the aircraft. The vertical and horizontal positioning of the aircraft along with any avionic device that supports this landing stage need also be paid attention to. Students must also be knowledgeable about communication devices and various height measuring transducers. Students understand the performance of the device under normal conditions or when an anomaly occurs. At this time many
business processes on aircraft including landing processes are also regulated using computers, where computers regulate two or three dimensions of the aircraft's position before landing. For example, computers compute three reference points used in landing processes with input in the form of aircraft types, the weight of the aircraft in runway length weather conditions, also input from the omnidirectional range (VOR) VHF system. Students are also expected to know the computational processes carried out by computers.

3. Proposed Method
The following will elaborate the proposed method related to how to give instruction to students to be able to make the right decisions when problems occur, especially in aircraft landing systems.

3.1 Decision Objective Teaching for Instrument Landing System (ILS).
There are several main things that are emphasized on ILS, including determining the position of the aircraft's height before landing and horizontal position. This factor involves many devices and other support systems such as vertical and horizontal locators and adequate communication systems. The Instrument Landing System is the support system that responsible for the ability of aircraft to reach their destination more safety especially in bad weather but not only for bad weather. The Integrated Landing System is the aircraft support system that has already extended and integrated the instrument and computerized system for aircraft landing assistant. Here are some things in the landing process, which affects the setting the direction of the aircraft's altitude before landing. There are three points of reference that, according to regulations, must be met when the aircraft will land. To make it easier it can be shown in the figure 4 in the form of a matrix adapted from the avionic manual from reference [1].

![Figure 4. Landing Matrix.](image)

In the above model, the landing parameter is standard for a specific aircraft. Hence, there is an instrument that keeps the precision of parameter value. Otherwise, there must be system failure and the source of the problem will be found. To overcome this, several approaches using a performance base and a decision base teaching method are used. In order to simplify the steps to overcome them, several standardization steps are used so that students can learn them easily. General Standardization of steps systematically can be categorized as follows:

- Collecting information: the student sense the data and information manually or by instrument. The students better take all of the information as much as they can.
- Processing information: The collected data and information then will be validated and classified. There are many rules for data verification, such as international aircraft standard or vendor standard.
• Making decisions: There are many approaches to decision-making, beside the risk factor consideration. Practically there are two types of decision making approaches, namely the critical time and sufficient time approaches. They both have a certain impact relate to the risk factor.

• Execute decisions: The decision can be executed sequentially or in parallel.

All information is outlined in milestones that are correlated with each other. The form of the milestone can be in the form of mind mapping or radar matrix. By summarizing them in an integrated manner, you will see the possibility of a mismatch or the appearance of an error. This method makes it easy for us to do troubleshooting manually or using a computer software application related to aircraft decision making.

3.2 Milestone Model
There are several forms of milestone that will be submitted to make it easier for students to make notes about the device for further analysis.

3.2.1 Checklist

| Part | symptom | value | measurement | value | standard | inspection | note |
|------|---------|-------|-------------|-------|----------|------------|------|

**Figure 5. Check List.**

This type of milestone summarizes and compares with the standard data in the aircraft maintenance standard book and helps provide a quick response in damage assessment

3.2.2 Radar Risk matrix. There are several levels of risk in this matrix. By knowing the risks that might occur, students must wisely consider the policies that occur when decisions are made.

**Figure 6 Radar Risk Matrix courtesy of Teamgantt.**

This type of milestone helps in measuring the level of possible impact caused by system damage. The relationship between radar matrixs and problems occurs with the landing system. A student must be able to make decisions by considering the risks. If all choices are unprofitable, then the best decision must be made. How to categorize the best of the best is using radar matrix. On radar matrix there is a level of risk that might occur.
3.2.3 Flowchart

![Flowchart Diagram]

Figure 7. Flowchart.

This type of milestone assists in sequentially way. The making of this flowchart is inspired by the ideas in the book on decision making by the Federal Aviation Administration. Various terminology, parameters and constrain can be used in making this flowchart. Entering the expected conditions can also be one part of the flow like this.

4. Case Study

On an aircraft landing, a miscalculation of the aircraft's length may result in an accident. At the time of the landing, when the weather was rainy, then a long body type aircraft needs runway category I. What do you think should be considered by an aircraft technician if this happens outside of human error made by the pilot. Knowledge of runway length and aircraft height must be basic knowledge that technicians must also understand. Following table is an example of a standard runway length and height of aircraft.

| Runway Category | Decision Feet | Runway Visibility Range Feet |
|-----------------|---------------|-----------------------------|
| I               | 200           | 1800                        |
| II              | 100           | 1200                        |
| IIIA            | 50            | 700                         |
| IIIB            | 0=>50         | 150                         |
| IIIIC           | 0             | 0                           |
Technically, according to the performance base teaching, a technician must understand the various avionic hierarchies of planes related to the landing system. Technicians classify the avionic system whether at the system, subsystem or component level [2]. The first thing to review is the suitability of aircraft specifications with the type of runway. The next thing to review is the Flight Data recorder and Cockpit Voice Recorder notes regarding the aircraft's height before landing and communication with Air Traffic Control. The next stage in terms of recording the speed of the aircraft must be adjusted to the weather, runway length and weight of the aircraft. The condition of the gear system is also an important concern. After all are considered, all the sensors related to data retrieval needed for landing must be verified. All this information will be summarized in a milestone to facilitate the verification and validation process. The process of overcoming this problem is described narrative. Next will be described in the following milestone checklist form .

Table 2. Checklist Milestone.

| Detect      | Identification | Action | Evaluate |
|-------------|----------------|--------|----------|
| Weight      | overweight     | reduce | wrong    |
| Speed       | Overspeed      | break  | wrong    |
| before touch down high | too high | lower altitude | wrong |

This table summarizes the condition of the plane that crashed during the landing process.

5. Conclusion
This paper discusses problems that may arise when technicians make wrong or incorrect decisions when troubleshooting. By using objective teaching methods in which there is a performance base and decision base teaching, it is proposed that standardization of steps when solving problems is assisted by various types of milestones. By describing information and decisions taken in the form of well-coordinated milestones, the possibility of failure is minimized. As a step forward, applications can be made in the form of computer-based software that can simplify the decision-making process and are expected to be more accurate.

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