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Example applications of the algebra of logics to the decision making problems of the aircraft airworthiness support technologies (aviation legislation and operational documentation concern)

It is made an attempt to propose a few examples that may relate to making decisions at conducting investigations or analyses. The material could be helpful optionally for either aviation legislation or operational documentation practical problems involving the mathematical logics operators in regards.

Introduction. The tasks of the aircraft airworthiness support technologies and related aeronautical engineering maintenance activities [1-5] are tightly connected with the aviation legislation and operational documentation issues. The paper considers optionally either aviation legislation or operational documentation example problems involving mathematical logics operators in regards. The prototypic problems have been found in reference [6]. A few applications to the area of technical operation have been already done in reference [7]. An interesting development could be with the use of the algebra of logics [8, p. 490] and the entropy paradigm [9] adapted to [10-33] doctrine.

Example 1. Prototype problem with necessary theoretical explanations see in [6, Chapter II, § 1, pp. 30-37], [7, pp. 36-38], [8, p. 490].

For instance, let us make up ***a fake story*** (everything is invented: names, places, events etc.). Imagine a supposition that: "There happened an accident to an aircraft of a contracting State (*Brumcashirma*) involving serious injury. In order to institute an inquiry into the circumstances of the accident in the best possible way the responsible person, *Paintoak* by name, received the following preliminary information from his/her three subordinates/minor inspectors. They reported where and what happened.

The first subordinate, named *Halambuta*, reported that the accident occurred in the territory of another contracting State (**Ckrackostan**) and that was because of **hitting a mounting**.

The second minor inspector, *Tumberson*, said that it happened in the State of **Pertambru** due to a thunder storm **lightning strike**.

The third, *Aucticus*, reported – the State is **Eucaria** but the accident does not have anything in common with **hitting a mounting**.

So, these three inspectors, willing to entangle their Chief Paintoak or hide the truth or on some other unknown reasons, each of them cheated Paintoak, i.e. telling him/her correctly either the State (the place, the first part of their reports, where it happened) or the second part of their reports (what has occurred). Paintoak has to discover what and where really happened in order to appoint a proper investigation commission."

Knowing the conditions revealed above and the laws of mathematical logics [6-8], Paintoak does not have to go to the accident site. As each of the minor inspectors deceived Paintoak only a half, truthfully saying either State or the second part of their

reports, then it means that by the algebra logics theorem for summation each of them reported the true (correct) statement. Namely:

Halambuta: "**Ckrackostan, hitting a mounting**", the true specific is either State of "**Ckrackostan**" – statement "*Ckr*", **or** ("+" logic operator) the result "**hitting a mounting**" – statement "*hm*". That is

$$Ckr + hm = True. \qquad Ckr \cdot hm = Wrong. \tag{1}$$

Thus Halambuta's statement in (1): "Ckrackostan **or** hitting a mounting", is the "*True*" statement. For "Ckrackostan **and** hitting a mounting" we see the "*Wrong*" statement in (1). In an analogous way, Tumberson: "**Pertambru, lightning strike**":

$$Per + ls = True. \qquad Per \cdot ls = Wrong. \tag{2}$$

Here "*Per*" is for Pertambru; "*ls*" – lighting strike. Aucticus: "**Eucaria, not hitting a mounting**":

$$Euc + \overline{hm} = True. \qquad Euc \cdot \overline{hm} = Wrong. \tag{3}$$

where *Euc* – Eucaria; $\overline{hm}$ – **not** hitting a mounting.

This means, that accordingly to the multiplication theorem, the product of statements (1)-(3) is also the true statement, [6-8]:

$$(Ckr + hm) \cdot (Per + ls) \cdot (Euc + \overline{hm}) = True. \tag{4}$$

$$Ckr \cdot Per \cdot Euc + Ckr \cdot ls \cdot Euc + hm \cdot Per \cdot Euc + hm \cdot ls \cdot Euc +$$

$$+ Ckr \cdot Per \cdot \overline{hm} + Ckr \cdot ls \cdot \overline{hm} + hm \cdot Per \cdot \overline{hm} + hm \cdot ls \cdot \overline{hm} = True. \tag{5}$$

Here, in (5), at least one of the eight members must be true. The only one member $Ckr \cdot ls \cdot \overline{hm}$ does not have any contradiction. That means it is true. The rest is fake. Thus, the accident occurred in the territory of **Ckrackostan** State and that was the **lightning strike**. We have found the truth, though each minor inspector lied: second equations in (1)-(3).

For **operational documentation** issues the parallel ***invented story*** could be: "There has been performed a maintenance operation of an aircraft. Analyze which it was and which kind of operational documents has been completed accordingly if it is known exactly, from each of the following three reports, the correct sort of the executed work or the operational document completed and the rest of the report is a false information:

1. The report to the maintenance organization after the scheduled engine checking.
2. The fuel system fine filters elements replacement with the notification issuance for the Operator.
3. The work order registration but not for the fuel system fine filters elements replacement."

Example 2. [6, Chapter II, §§ 1-4, pp. 30-57], [7, p. 39], [8, p. 490].

Suppose a continuation of ***the fake story***. "In conditions of the previous example Chief Paintoak has known:

1. If the first subordinate, named Halambuta plotted to cheat the Chief, then the second minor inspector, Tumberson is also guilty in that lying.

2. But it is not true, that if the third, Aucticus, has done this, then the second minor inspector, Tumberson is also to be blamed at it.

Chief Paintoak wants to find out who tried to deceive him/her.

In such problem setting, in terms of mathematical logics [6-8], we have two implications. For the point 1 and 2 respectively:

$$1 \Rightarrow 2 . \qquad \overline{3 \Rightarrow 2} . \qquad (6)$$

1, 2, 3 in (6) mean the numbers of the inspectors who did it. Then, from the true expressions of (6) it follows the true product of the implications:

$$(1 \Rightarrow 2) \cdot \left(\overline{3 \Rightarrow 2}\right). \quad \text{It leads to} \quad \left(\bar{1} + 2\right) \cdot \left(\overline{\bar{3} + 2}\right). \quad \left(\bar{1} + 2\right) \cdot \left(\overline{\bar{3} \cdot \bar{2}}\right). \quad \left(\bar{1} + 2\right) \cdot 3 \cdot \bar{2} .$$

$$\bar{1} \cdot 3 \cdot \bar{2} + 2 \cdot 3 \cdot \bar{2} . \quad \text{The true is} \quad \bar{1} \cdot 3 \cdot \bar{2} . \qquad (7)$$

The lye was plotted by neither the first nor the second but by the third inspector Aucticus.

For **operational documentation** interpretation again ***made up story***: “Which are you going to do on condition that:

1. If the first sort of aviation operational documentation has to be completed, then the second type of the documents is also must be filled.

2. But it is not true, that if the third kind of the documentation is to be prepared, then the second type of the documents should also be completed?”

It seems prospective and promising to combine the given approach with the entropy doctrine [9-33]. The material is to be continued in further research.

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