Using the flight-number flashing feature to enhance the air traffic controllers' performance and situation awareness on radar the display

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Introduction

- In the Air Traffic Control (ATC) world, controllers face enormous challenges while separating the traffic, especially in congested airspace. It is astonishing that at any given moment, approximately 5000 flights flying in the U.S. airspace, Therefore, radar systems are considered as one of the most important innovations man had ever made in the 19th century to serve the aviation world.
- Some frequent critical situations may occur on the radiotelephony resulting in an extremely negative impact on the controllers' performance and situation awareness (SA), the air traffic, and the safety of the airspace. In the best circumstances, these situations waste both controllers' and pilots' time and energy, such as:
  1)Blocking the radio mistakenly by a pilot, known as the Stuck-Mic.
  2)The simultaneous transmission by two or more stations on the radio.
  3)The wrong call-sign identification or confusion due to similarity in numbers or company code or both.
- What makes the situation worse when two or more of these critical situations happen at the same time.

Research Question and Hypothesis

- The following research questions where addressed to test the null hypothesis.
  H1: Are there any significant differences in the Air Traffic Controller's performance when using the new Flight-number Flashing Feature (FFF) instead of using the current Non-Flashing Flight-number (NFF) on Radar Display?
  H_0 1: There is no significant difference in the controller's performance when using the Flashing Flight-number Feature instead of using the current Non-Flashing Flight-number on Radar Display.
  H2: Are there any significant differences in the controller's Situation Awareness when using the new Flashing Flight-number Feature instead of using the current Non-Flashing Flight-number on Radar Display?
  $H_0$2: There is no significant difference in the controller's Situation Awareness when using the new Flashing Flight-number Feature instead of using the current Non-Flashing Flight-number on Radar Display.

Methodology

- Eighteen ERAU students representing the ATC population sample size have randomly assigned for the experiment.
- The within subject design paired *t*-test and counterbalancing has applied to eliminate the order effect.
- A computer software similar to the ATC radar system has designed and coded especially for this experiment.
- The new simulation software has given a name called the Flight-number Flashing Feature (FFF).
- The reason for coding this software was to test the cause and effect where the NFF and the FFF may define as the cause that may have different effects on the controller's performance and the SA.
- The software contains 55 flight call-signs related to 28 flight companies plus two flights using their registration numbers as callsigns. Each call-sign previously recorded by different pilot voices then saved in the software database. The pilots' announcements have designed to run automatically and randomly every 15 seconds time interval. Keeping in mind that, whenever the participant clicks the right announcing station, the time interval will omit, and the next flight announces.
- The simulation contains one stuck-mic flight and two simulations announcing flights. The number of occurrences for the stuck-mic, and the simultaneous announcing flights designed to occur once every five minutes. The software designed to report when each participant clicks on both the simultaneously announced flights and the stuck microphone at each session.
- Also, the software has counted the missing flight-numbers the participants were not able to find within the 15 seconds time interval. The wrong clicked flight numbers due to call-sign similarity have counted as well.
- 20 survey questions have set for 10 minutes by the end of the experiment. The main reason for this survey was to measure the participants' satisfaction on a scale from one to 10 degrees.

Results

- The SPSS program has conducted to analyze the collected data from the survey by using the descriptive statistics. by looking at Table 1 and Table 2, the reader will see the mean and standard deviation related to 12 survey questions related to the participants' performance and SA while using the FFF.

Table 1 *Q.3, Q.4, Q.6, Q.12, Q.19 (A), Q.19 (B), and Q.20 on Scale of Awareness*

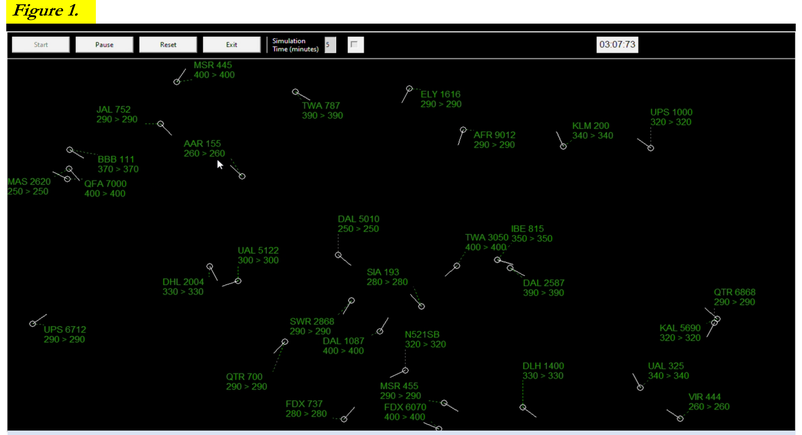
	N	Mini.	Max.	Mean	Std. Dev.
Q.3: Scale of Awareness	18	10	10	10.00	.000
Q.4: Scale of Awareness	18	8	10	9.83	.514
Q.6: Scale of Awareness	18	9	10	9.94	.236
Q.12: Scale of Awareness	18	6	10	9.56	.984
Q.19 (A): Scale of Awareness	18	8	10	9.61	.608
Q.19 (B): Scale of Awareness	18	8	10	9.67	.686
Q.20: Scale of Awareness	18	9	10	9.83	.383
Valid N (listwise)	18				

- The sum of means = 9.82 out of 10 degrees which reflects that the participants were extremely satisfied about their performance and SA while using the flashing feature.

Table 2 *Q.2, Q.11, Q.13, Q.14, and Q.18 on Scale of Performance*

	N	Mini.	Max.	Mean	Std. Dev.
Q.2: Scale of Performance	18	9	10	9.94	.236
Q.11: Scale of Performance	18	9	10	9.78	.428
Q.13: Scale of Performance	18	8	10	9.89	.471
Q.14: Scale of Performance	18	9	10	9.94	.236
Q.18: Scale of Performance	18	9	10	9.83	.383
Valid N	18				

Figure 1.



The Flight-number Flashing Feature (FFF) simulation software that designed for this research. This picture captured at 3 min. 7 sec. and 73 part of a second simulation runtime

- The first *t*-test results in Table 3-A shows that there is a significant difference between the FFF and the NFF sessions, $t\,(17) = 15.339$, $p < .001$. This indicates that participants' have been responding to more flights during the FFF session ($M = 284.793$, $SD = 6.258$) than the NFF session ($M = 139.584$, $SD = 38.748$), Table 3-B.
- Cohen's $d = 3.615$, indicates large effect size.

Table 3-A *The Mean Difference Between the Number of the Correctly Identified Flight in the FFF and the FFF Sessions*

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Num. of correctly identified flights in the FFF session – The NFF	70.89	21.263	5.012	60.32	81.46	14.15	17	.000

Table 3-B *The Mean and Standard Deviation for the Number of Correctly Identified Flights in the FFF and the NFF*

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Number of correctly ident. flights in the FFF	89.39	18	18.693	4.406
	Number of correctly ident. flights in the NFF	18.50	18	6.401	1.509

- The second *t*-test results in Table 4-A shows that there is a significant difference between the FFF and the NFF sessions, $t\,(17) = 15.339$, $p < .001$. This indicates that participants' have been responding to more flights during the FFF session ($M = 284.793$, $SD = 6.258$) than the NFF session ($M = 139.584$, $SD = 38.748$), Table 4-B . Cohen's $d = 3.615$, indicates large effect size.

Table 4-A *The Mean Difference Between the Number of Total Response Time f or the Correctly Identified Flight during the FFF and the FFF Sessions*

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Total response time for the correctly identified flights during the FFF session – The NFF session	145.21	40.16	9.47	125.24	165.18	15.34	17	.000

Table 4-B *The Mean and Standard Deviation for the Total Response Time for the Correctly Ident. Flights in the FFF and the NFF Sessions*

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Total response time for the correctly ident. flights in the FFF session	284.793	18	6.258	1.4751
	Total response time during the NFF session	139.584	18	38.748	9.133034

- The third *t*-test results found that more participants have confused and wrongly identify some flights due to the similarity in call-signs during the NFF session (M =1,17, SD = 0.924). On the other hand, none of the 18 participants have confused and wrongly identify any flight during the FFF session (M =0.00, SD = 0.00). That means the participants' performance and SA have enhanced after using FFF on the RD, Table 5.

Table 5 *Mean and Standard Deviation for the Number of Wrong Identified Flights due to Callsign Similarity During the NFF Session and the FFF*

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Number of wrong identified flights due to callsign similarity during the NFF session	1.17	18	.924	.218
	Number of wrong identified flights due to callsign similarity during the FFF session	.00	18	.000	.000

Discussion, Conclusions, and Recommendations

- Using the FFF provide the radar controller a 99.9% accuracy to identify any flight blocking the radio known as "The stuck microphone".
- In the second *t*-test to calculate the controllers' delay in response time to identify any announcing flight on the RD it is found that it could be calculated by dividing the total response time for the correctly identified flight in the FFF session on the number of correctly identified flight in the same session. By applying the same calculation on the NFF results then comparing both values, it is found that the controller were spending an average of 7.55 second during the NFF session to identify each announcing flight on the screen while spending an average of 3.2 seconds only during the FFF. This could be interpreted to that using the FFF reduced the verbal communication between pilots and controllers by approximately 57.62%.
- A revision has been conducted for the participants' archived results on the software database to see which call-signs were confusing the participants the most. All the wrongly clicked flights due to confusion have collected in Table 6.

Table 6 *The Participants' Mistake or Confusion in Identifying Flight-Numbers during the NFF Session*

Similarity between two or more callsigns			
Pilots' Announced callsigns	Wong clicked by the controllers due to Similarity	Number of occurrences	Reason for wrong identification or confusion due to similarity
JAL 752	UAL 325	1	Company ICAO code
UAL 325	UAL 5122	1	Company ICAO code
KLM 200	QTR 700	1	Number
QFA 7000	DLH 1400	1	Number
MSR 455	DAL 4455	2	Number
MSR 455	MSR 545	1	Both company ICAO code and/or number
MSR 545	MSR 445	1	Both company ICAO code and/or number
MSR 455	MSR 445	3	Both company ICAO code and/or number
MSR 445	MSR 455	3	Both company ICAO code and/or number
DHL 4200	DHL 2004	1	Both Company ICAO code and/or number
DAL 1087	DAL 2587	1	Both company ICAO code and/or number
QFA 7000	QTR 700	2	Both company ICAO code and/or number
QTR 700	QFA 7000	2	Both company ICAO code and/or number

- Three types of mistakes have noticed. The first could be due to the company ICAO code and/or the number, such as the case between MSR 445 and MSR 455. The second type could be due to similarity in numbers only such as, the case in KLM 200 and QTR 700, noticing that number zero mentioned twice. The third type occurred could be due to similarity in the ICAO codes only, such as the case between flights UAL 325 and UAL5122. It is worth noting that only the confirmed wrong clicked flights that passed the 15 seconds time interval have counted as wrong. The reason for giving a chance for the participants' controllers to revise and make corrections is to simulate the reality where controllers make mistakes and corrections while working on the radar. Therefore, a second in aviation taken into consideration where it could make a difference and may save peoples' lives.
- Additionally, the simulation software has designed free of routes or corridors to simulate the future of air navigation.
- In Table 6, it is found that the highest number of participant's confusion due to the similarity in flight-numbers happened three times between MSR 445 and MSR 455. The second-highest occurrence happened twice between MSR 455 and DAL 4455. It is observed that the letter "f" may be the reason for this confusion, where it is a common letter in numbers four and five, it may confuse pilots and controllers if it pronounced repeatedly. In parallel to that, the letter "S" is also common in numbers six and seven. These numbers may confuse controllers and pilots if they mention in one callsign. It is recommended that the FAA, the ICAO, and the IATA publish an advisory circular to all the flight companies to stop using any of these numbers combined in one callsign. .
- Subject to the study results, adopting the FFF to the current radar system could reduce the length of the radio occupation time for both pilots and controllers by 57.7% while maintaining safe operation. Keeping in mind that preserving a single second in aviation could make a difference and may save people's lives. These few preserved seconds during the verbal communication process may reduce workload and fatigue. Also, pilots and controllers may invest these few seconds in other important tasks rather than wasting their time in excessive radio calls.

References

- link to YouTube video providing quick tips about the FFF: https://youtu.be/3NkLxqYmANE