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> *"The goal of a scientist is to uncover new ideas, concepts and tools, practical or theoretical, that extend our understanding of the world around us and enable us to do new things. One must believe in what one is doing and stay the course. Now of course, in science one can ultimately prove the correctness of one's work by appeal to experiment and established theory. But even with this buttressing of one's ideas, acceptance can be a long and difficult road."*

Richard F.W. Bader (1931 – 2012)
Grand Fellow of the MIRCE Akademy

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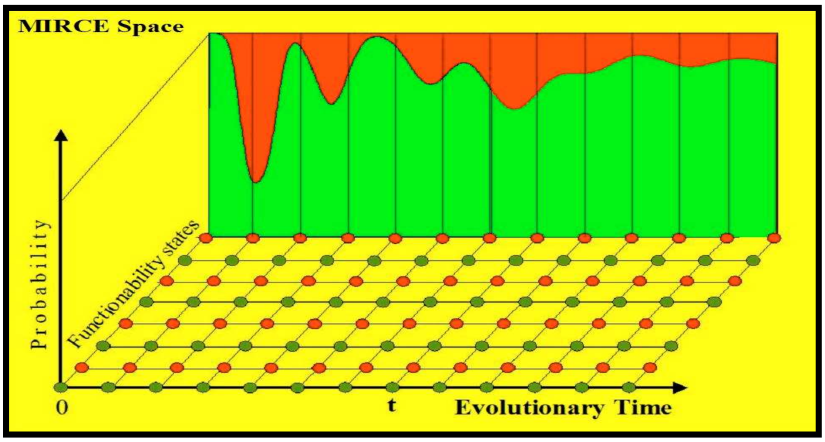
Content

MIRCE Science

The philosophy of MIRCE Science is based on the premise that the purpose of existence of any functionable system[1] *is to do functionability work, which is considered to be done when the expected measurable function is performed through time, like miles travelled, units produced, energy supplied and similar. However, experience teaches us that at any instant of in-service life there is a probability of work being interrupted by occurrences of negative functionability events, resulting from failures of consisting components, natural causes, human actions or their interactions. For the work to be continued, humans undertake appropriate positive functionability actions, like: maintenance tasks, change of the mode of operation and similar must be performed. Thus, the life of functionable systems is a sequence of transitions through functionability states. Typically, functionability performance (the amount of work done and resources consumed to support operation and maintenance) becomes known through the end of the life statistics*[2]*, which c ertainly could be change at that stage..*

After five decades of systematic studies (practical and observational) of in-service behaviour of functionability systems and their performance Knezevic [1] has generated a body of knowledge, named MIRCE Science, which describes the motion of functionable systems through MIRCE Space[3]*. Its axioms, equations and computational methods enable predictions of expected performance to be done, well before the design has been finalised, for each of physically feasible alternative. It is based on the scientific understanding of the physical mechanisms that generates the occurrences of functionability events, considered within a physical scale between* 10^{-10} *m (atomic scale) and* 10^{10} *m (solar system scale). These mechanisms, together with the human imposed rules, quantitatively define the expected functionability performance.*



Reference: [1] Knezevic, J., The Origin of MIRCE Science, pp. 232, MIRCE Science, Exeter, UK, 2017, ISBN 978-1-904848-06-6

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[1] Functionable system is a set of the constituent things from natural and human worlds arranged to deliver at least one measurable function. [1]

[2] Pan Am's Boeing 747, registration number N747PA, during the 22 years of in-service life, has delivered 80,000 hours of positive work (transported 4,000,000 passengers, burned 271,000,000 gallons of fuel) while receiving 806,000 man-hours of maintenance work (consuming: 2,100 tyres, 350 brake systems, 125 engines, among other parts.

[3] MIRCE Space**:** a conceptual 3-dimentional space containing MIRCE Functionability Field, which is an infinite but countable set of all possible functionability states that a functionable system could be found in at any instance of calendar time and the corresponding probability of being in those states. [1]

MIRCE Science Approach to Maintenance of Microbial Contamination of Fuel Tanks in COVID-19 Grounded Aircraft

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Microbial contamination of aviation fuel tanks is a known physical phenomena to airlines that are dealing with it in accordance to manufacturer guidelines. However, as the disastrous COVID-19 pandemic has left aircraft grounded and scattered across airfields around the world there is a danger that contaminated fuel could cause undesirable consequences to a fuel system like:

clogging of fuel filters, corroding tanks, performance degrading combustion quality, as well as damaging the rubber components specific to the fuel tank, thus impacting the functionability performance of an aircraft. A full understanding of these mechanisms is essential for the determination of the most effective maintenance policy for testing the fuel of grounded aircraft. Thus, the main objective of this paper is to address microbial contamination of fuel tanks in COVID-19 grounded aircraft as a potential mechanism of the motion of an aircraft through MIRCE Space. Recommendations for the fuel contamination testing maintenance programme are presented in the paper, which should assist airlines to ensure that fuel systems of over 20,000 temporarily grounded aircraft are safe when the time comes for them to resume operations.

Kay words: MIRCE Science, microbial contamination, aviation fuel tanks, CODIV-19 grounded aircraft, fuel testing maintenance programme

1. Introduction

The principal function of aircraft fuel tanks is to function as a wing and then as a fuel tank. Thus, the design of a wing structure does not allow a single simple sump, but it creates lots of difficult to drain water traps. While an aircraft is in regular operation, a system of specially shaped pipes is designed in the fuel tanks that mix any water back in with the fuel to prevent microbes accumulating.

Due to the global pandemic of corona virus COVID-19, around 80% of the world's fleet of commercial aircraft were grounded during most of 2020 creating conditions for the water accumulation in their tanks. The situation is even more critical during the summer months when the rising temperatures create conditions ideal for the growth of microbes. During the pandemic aircraft are on the ground all the time. Hence, the fuel system, the fuel, and the water get to an ambient temperature, which in most parts of the world in summer is over 30° C. In fleets that have not been treated with biocide the first signs of microbial growth begin to show after two to three months of storage.

The reduction in movement of aircraft during the COVID-19 outbreak has raised concerns over microbial contamination and the damage this can do to aircraft fuel systems, especially when they are in hot, humid regions that facilitate the rapid growth of micro-organisms.

Many of these aircraft have been in "active storage" with some fuel remaining in the tanks. Although that fuel is often treated with biocide, the threat of microbial contamination still exists. This is because fuel is warm for extended periods without being in flight and fuel is also static, so “hotspots” of contamination may occur that are very difficult to detect.

Experience teaches us that the storage and distribution of aviation fuel has “challenges” regarding the control and prevention of the growth of microbes (bacteria and fungi) in fuel tanks. Presence of water enables microbes to grow and multiply in the fuel tank, and then to get transferred to other tanks and continue propagating. The contaminated fuel could cause undesirable consequences like: clogging of fuel filters, corroding tanks and performance degrading build up of deposits caused by the acids the microbes excrete which cause fuel to break apart and lose combustion quality. Thus, the main objective of this paper is to address microbial contamination of fuel tanks in COVID-19 grounded aircraft as a potential mechanism of the motion of an aircraft through MIRCE Space. Recommendations for the contamination testing maintenance programmes for aircraft scattered over airfields away from usual lab testing facilities are presented in the paper in order for operators to ensure that fuel systems of over 20,000 aircraft are safe when the time comes for them to resume operations.

MIRCE Science Fundamentals

3. Types of aviation fuel contamination

3.1 Water

3.2 Particulates

3.3 Microbial growth

4. Mechanisms of attack by microorganisms

5. Impact of Microbial Growth of Aircraft fuel system

5.1 Microbially Influenced Corrosion of Alloys used in Aircraft Fuel Tanks

5.2 Impact of microbial contamination on filters in the aviation fuel supply chain

5.3 Impact of microbiological contaminants on the quality of aviation fuel

6. Impact of the COVID-19 on the contamination of fuel and fuel tanks in grounded aircraft

7. Microbial contamination related maintenance tasks

7.1 Fuel sampling

7.2 Topping up fuel tanks

7.3 Inspection of fuel system screens and filters

8. Frequency of fuel testing for microbial contamination

9. Conclusions

Microbial contamination of aviation fuel tanks is a known physical phenomenon to airlines that are dealing with it in accordance to manufacturer guidelines. However, as the disastrous COVID-19 pandemic has left aircraft grounded and scattered across airfields around the world there is danger that contaminated fuel could cause undesirable consequences for a fuel system. Thus, a full understanding of these mechanisms is essential for the determination of the most effective maintenance policy for testing the fuel of grounded aircraft.

Microbiological contamination of fuels can cause operational problems, such as corrosion of metallic structures, fuel quantity indication problems, and blocking of the scavenge systems and fuel filters during flight. There are a number of signs that will indicate that fuel tanks are contaminated such as evidence of contamination of fuel filters, discoloration of sump sample, blocking of fuel injectors, erratic/inaccurate fuel level readings. For example erratic behaviour of the fuel quantity gauging system can be a sign of microbiological contamination, as most gauging systems are capacitance based and the microorganisms have a different capacitance than fuel.

While aircraft fuel contaminants can prove difficult to control, employing a solid fuel quality monitoring system through a series of tests will ensure that aircraft fuel stays clean. Whether in the aircraft or stored in a long-term facility, it is important to understand the potential of microbial growth, taking appropriate measures to search for it, and then removing any sludge, thereby keeping the fuel microbial free is an integral part of preventive maintenance process of any airline.

As the duration of the COVID-19 pandemic is unknown, ultimately the point could be reached where de-fuelling is required, especially if it’s for disposal because it’s been contaminated. In those cases some additional maintenance actions will be required because disposal of contaminated fuel is not something that is routinely done at temporal storage facilities. The logistics of this process is rather challenging regarding the availability of additional resources, like: injection carts, availability of the additives and also simple things like being able to access aircraft that are parked nose to tail on airports runways.

Recommendations for the fuel contamination testing maintenance programme are presented in the paper, which should assist airlines to ensure that fuel systems of over 20,000 temporarily grounded aircraft are safe when the time comes for them to resume operations.

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Cannibalisation as a functionability action of MIRCE Science

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Abstract

The main objective of this paper is to examine the cannibalisation process, removing a required component from a designated system and installing it on the unserviceable system, as a functionability action of MIRCE Science. It impacts the work done of a functionable system and resources consumed during a given interval of calendar time. Although the cannibalisation process improves profitability or readiness of functionable systems, it can also lead to increased costs and disruption by diverting resources from other activities and create additional technical and financial risks. Thus, cannibalisation is one of the drivers of profitability that could be predicted by applying MIRCE Profitability Equation, which considers the whole organisation as a single analytical scheme. It is a huge improvement in respect to current practices where the whole business process is partitioned into a large number of self standing models that address a few influential parameters at a time. Example of cannibalisation in Royal Navy is given in the paper.

Key words: cannibalisation, functionability, profitability. readiness

1. Introduction

The philosophy of MIRCE Science[4] is based on the premise that the purpose of existence of any functionable system[5] is to deliver the expected work. The work is considered to be done when measurable functionality (function, performance and attributes) is delivered through time, like: annual miles travelled, monthly units produced, daily energy supplied and similar.

The main business of any business is to stay in business by providing a revenue-generated work. Hence, the three of the least liked words in commercial aviation business are aircraft on ground (AOG). The following example is one of the possible scenarios of AOG: a passenger aircraft is due to departing, on a scheduled flight, at 16:00 with 235 fare-paying passengers. The pre flight test has shown that a safety critical avionics module has failed, which is not on Minimum Equipment List. To meet operational requirements and to dispatch the aircraft on time it is necessary to replace a defective component. The regular maintenance procedure is completed by issuing a replacement component from the inventory and releasing the aircraft into service after its installation. However, the on-line mechanics investigation has concluded that a replacement part is not available in the inventory. An interrogation of airline's available inventory reveals that module required could be delivered in 14 hours time. This means

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[4] MIRCE Science is a theory that subjects functionability phenomena to the laws of mathematics and computes time, space and human driven performances. (www.mirceakademy.com)

[5] According to Knezevic, Functionable system is operationally defined functional system. [1]

that the another aircraft has to be found to delivered the scheduled flight or that the 235 passengers and the crew have to be taken care of in local hotels till the needed component arrives. The other options to authorise cannibalisation (robbery) process. It means that the required component is removed from a designated aircraft (the donor aircraft), inspected, and installed on the unserviceable aircraft (the receiver aircraft. When the work is completed, the aircraft is dispatched into regular service. An AOG can happen at any time, anywhere in the world, and when it does, every minute the aircraft sits on the ground is critical.

The main business of any defence organisation in any country is to satisfy the defence requirements by providing operation ready weapon systems. They focus on a fleet readiness and the budget allocated for maintaining inventories of spare parts. Hence, all military services rely extensively on cannibalisation and consider it to be a normal part of fleet maintenance. A recent study identified approximately 850,000 documented US Air Force and Navy cannibalisations that consumed 5.3 million maintenance hours, during the period of five-year. [2]

While cannibalisation provides a short-term solution that makes a functionable system operational, its long-term impacts can be significant.

The main objective of this paper is to address cannibalisation as a functionability phenomenon of MIRCE Science, which uniquely determines the time emerging functionability performances, like: work done, resources consumed and consequential profitability in private sector or operational readiness in defence sectors. The body of knowledge presented here is of a generic nature, which means that is applicable to any work delivering functionable system.

2.0 Fundamentals of MIRCE Science

3.0 Managing spare parts demands in commercial aviation

4. The anatomy of cannibalisation
4.1 Technical impact of cannibalisation
4.2 Financial impact of cannibalisation
4.3 Example of equipment cannibalisation in the Royal Navy

5. Planning for cannibalisation

6. Impact of Cannibalisation on profitability

6.1 The expected revenue

6.2 The expected cost categories in MIRCE Science

6.2.1 The expected cost of positive work

6.2.2 The expected cost of negative work

6.3 The expected profit

7. Conclusions

The main objective of this paper was to examine the cannibalisation process, removing a required component from a designated system and installing it on the unserviceable system, as a mechanism of the motion of a functionable system in MIRCE Science. It impacts the functionability work done and resources consumed during a given interval of calendar time. Although the cannibalisation process improves profitability or readiness of functionable systems, it can also lead to increased costs and disruption, divert resources from other activities and create additional technical and financial risks. Thus, cannibalisation is one of the drivers of profitability that could be predicted by applying MIRCE Profitability Equation, which considers the whole organisation as a single analytical scheme. It is a huge improvement in respect to current practices where the whole business process is addressed through a collection of a large number of self standing models that address a few influential parameters at a time.

The cannibalisation process must be rigorously managed and controlled to maintain regulatory and safety compliance, on one hand, and performing the trade-offs between saving measures, such as reducing investment in spares upfront, and the related longer-term value-for-money implications, on the other. Efficiency is also a priority, because the cannibalisation process is typically applied under operational pressure and tight deadlines. Finally, cannibalisation presents a challenging underlying technical risks, subsequent consequences on testing during the operational process and cost implications on the long term financial support of the maintenance of heavily cannibalised components/equipment.

8. Acknowledgement

The author wishes to thank the American Journal Novel Research in Sciences for support given towards publishing of this paper.

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Mathematical and Physical Reality of Reliability

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Abstract

According to Knezevic [1] the purpose of the existence of any functionable system is to do work. The work is done when the expected functionality (function, performance and attributes) is delivered through time. However, experience teaches us that the work expected to be done is frequently beset by failures, some of which have safety consequences to: the users, the natural environment and human communities[6]*. Thus, from the late 1950s reliability models, based on a reliability function, have been used to predict the impact of the design decisions on in-service reliability and safety, before finalising the design. As the accuracy of these predictions is fundamental for the formulation of failure management policies, the author has studied the physical properties that future systems must possess, in accordance with the mathematical view of reality, firmly imbedded in their reliability block diagrams. The results of the study are presented in the first part of the text. These findings are tested through scientific studies of a large number of physically observed failures generated by operation, maintenance and support processes of defence, aerospace and nuclear power systems. The results obtained, presented in the second part of the text, show significant discrepancies between the mathematical reality of reliability based on axioms of probability imbedded in reliability function and the physical reality observed through the scientific studies of numerous in-service reliability and safety related events. Thus, the main objective of this text was to expose the reliability and safety community to the mathematical and physical realities of reliability function with the objective to focus their attention to the following question, "What is the body of knowledge on which reliability and safety modelling should be based, in order for predictions made to be confirmed by reliability measures obtained in operationally defined physical reality?"*

Key words: reliability function, mathematical reality of reliability modelling, observed failure events, physical reality of reliability modelling,

1.0 Introduction

All engineering disciplines have been developed, several decades or even centuries, after the development of the relevant discipline of science. Thus, mechanical, electrical, nuclear, chemical, aeronautical and other types of well recognised and proven engineering disciplines have grown on the foundations made of mechanics, electrodynamics, fluid mechanics, thermodynamics, quantum mechanics and similar

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[6] Three Mile Island (1978 in USA), Chernobyl (1986 in USSR), Fukishima (2011 in Japan), Deepwater Horizon oil spill (2010, USA), NTPC power plant explosion (2017 in India) and numerous others.

scientific disciplines, fully defined by the proven laws and equations named after their creators like: Newton, Maxwell, Hamilton, Lagrange, Euler, Bernoulli, Boltzmann, Planck, Schrödinger, Heisenberg and other giants of science. These equations are used to make predictions of the performance of future engineering systems. However, in order to make any type of prediction a model of reality must be created, as science cannot look at the absolute reality. So, it could be safely said that all the above-mentioned equations of science are models of physical reality that predict results that are consistent with the measurements made. These measurements are the only "mechanisms" through which humans interact with physical reality. In summary, the greatest engineering "feats" like: steam engines; aircraft; power stations; communication systems; computers and numerous other systems have been designed by human ingenuity using models based on mechanical, electrical, nuclear, chemical, aeronautical and other types of well recognised and proven engineering disciplines.

With the development of advanced military, aerospace and nuclear industries, the necessity for their in-service reliability and safety became imperative. Hence, in the1950s, Reliability Engineering was "created" by these industries. To the best of this author's knowledge there was no "father" figure of reliability and safety comparable to Newton or Maxwell. Thus, for the first time in engineering history the process of the creation of an engineering profession has preceded the process of the creation of the scientifically proven theory on which relevant models are built. The focus was on the data collection related to the number of failures that took place during the operation of systems. Massive attempts were made by the reliability and safety community to utilise the collected failure data and produce some measures of reliability. Hence, a Mean Time Between Failures[7] (MTBF) and its reciprocal, a failure rate (λ), became measures of reliability. They are primarily used for contractual purposes between producers and users, mainly within defence, aerospace and nuclear industries. However, these reliability measures only quantify the past performance of systems, rather than predict their future performance.

Deterministically educated design engineers and project managers could not improve the situation as they had huge difficulties in understanding these reliability measures, as they are totally different from all other measurable physical properties known to them. For example: pressure, temperature, volume, voltage, weight and similar can be measured directly. Even further, by applying existing laws of natural sciences, accurate predictions of these physically measurable properties for the future systems could be made. At the same time, the adopted measures of reliability are abstract and immeasurable directly, as they obtain a physical meaning only when the behaviour of a large sample is considered.

In absence of anything else, the practicing reliability and safety engineers, in the 1960s created a model of reliability that required the acceptance of the concept of an "alternative universe" where all the components, and consequently systems, possess a constant failure rate, leading to the following expression of the reliability function: $R(t) = \exp(-\lambda t)$. This approach stems from neither science nor mathematics, but from a desperate necessity to make reliability and safety predictions based on the in-service

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[7] Typically, it is calculated as a ratio between the total time of operation and the total number of observed failures, which is known as the arithmetic average, in mathematics. It is necessary to stress that no other measures could be obtained from this data.

information. Regrettably, these practises were “legitimised” by numerous industrial and military standards, created to demonstrate contractual compliance in legally binding acquisition processes, which is the case in many industries, continues even today.

In summary, reliability and safety engineers, knowingly or unknowingly, adopted this parallel universe where well-known and physically observed physical phenomena like: corrosion, fatigue, creep, wear and similar time-dependent mechanisms do not exist. They tried to rectify the situation by the invention of a bath-tub curve, the concept of which has never been incorporated into quantitative predictions of reliability and safety measures.

According to Knezevic [1] the collection of failure data and their statistical analysis by the reliability and safety community clearly demonstrated the following fact, “As the past can be quantified through statistical measures only, then the future can be predicted through probabilistic measures, only.” Consequently, the rest of the text will expose the currently used reliability function based approach to the modelling of reliability and safety, the accuracy of which is tested by the author through the analyses of a large number of physically observed failure events that have shaped the reliability and safety performance of defence, aerospace and nuclear power industries during the last 50 years.

2. Mathematical reality of reliability

2.1 The concept of failure function

2.2 Reliability model of a component

2.3 Reliability model of a system

3. Physical meanings of mathematical reality of reliability

3.1 Mathematical reality: Quality of components production is one hundred percent

3.2 Mathematical Reality: Errors during system transportation, storage and installation tasks are zero percent

3.3 Mathematical reality: All components are one hundred percent independent

3.4 Mathematical reality: Zero maintenance actions (inspections, repair, cleaning, etc.)

3.5 Mathematical reality: Continuous operation of the system and components

3.6 Mathematical reality: Time counts from the “birth” of the system

3.7 Mathematical reality: Fixed operational scenario (load, stress, temperature, pressure, etc.)

3.8 Mathematical reality: Reliability is independent of the location in space (GPS or stellar co-ordinates)

3.9 Mathematical reality: Reliability is independent of human actions

3.10 Mathematical reality: Reliability is independent of maintenance actions

3.11 Mathematical reality: Reliability is independent of calendar time (seasons do not exist)

3.12 Mathematical reality: Reliability is independent of the natural environment

3.13 Concluding remarks regarding mathematical reality of reliability function

4. Physical reality of reliability

4.1 Physical reality: Quality of produced components and assemblies is less than 100 percent

- A400M crashed by incorrectly installed engine software[8]
- Quality control issue halted F-35 deliveries to us government[9]
- Japanese rocket start-up blow up after 2 seconds[10]
- After in-flight diversion Boeing 777 production-line wiring inspections[11]

4.2 Physical reality: Transportation, storage and installation tasks are not 100 percent error free

- SpaceX explosion at launch pad[12]

- Leonardo calls for AW169 and AW189 tail rotor inspections[13]

4.3 Physical reality: There are interactions between “independent” components

- Power plant’s inlet cowl detached in midair of Boeing 737-700[14]
- Oil system flaw caused PW1524g engine uncontained failure[15]
- Faulty equipment partly due to crash of AirAsia flight QZ850[16]
- Ethiopian B787 fire due to runaway in the lithium-metal batteries[17]
- Smoke and fumes event involving Boeing 787[18]

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[9] MIRCE Akademy Archive- MIRCE Functionability Event 20191211
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[18] MIRCE Akademy Archive- MIRCE Functionability Event 20160417

- Pilots unaware of B737 MAX's automatic stall prevention system[19]

4.4 Physical reality: Maintenance activities like: inspections, repair, cleaning, etc., have significant impact on the reliability of a system

- In-service cracks trigger Airbus A380 wing-spar inspections[20]
- ANA grounded Boeing 787 for Rolls Royce engines inspections[21]
- Chemical residue causes in-flight shutdown to A380[22]

4.5 Physical reality: Neither all systems nor all components operate continuously

- Airbus A320 was flying with a failed actuator on minimum equipment list[23]

4.6 Physical reality: Components and a system have different "times"

- ANA to replace turbine blades on RR Trent 1000 engines on B787 fleet[24]
- International space station electrical issue delays SpaceX launch[25]

4.7 Physical reality: Variable operation scenarios (load, stress, temperature, pressure, etc.)

- Aeroflot Superjet 100 (RA-89098) crashed in Moscow[26]
- Hard landing of Wings Air ATR 72-600 in Indonesia[27]
- Gear retracted landing of Emirates B777-300 at Dubai[28]
- Weather scrubs SpaceShipTwo glide flight test[29]
- Airbus A319 safely landed after windscreen burst[30]

4.8 Physical reality: Reliability is dependent on the location in space defined by GPS co-ordinates

- Cold weather operations[31]
- GPS sensors data for forecasting dangerous solar storms[32]
- SpaceX delays launch due to weather[33]
- Passengers stranded after Delta flights grounded worldwide[34]

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[23] MIRCE Akademy Archive- MIRCE Functionability Event 20140322
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4.9 Physical reality: Reliability is dependent on humans

- Damage to Embraer business jet due to deviations from standard operation procedure[35]
- Catering track damage ramifications on Qantas A380 turn back[36]
- Human error behind Air Asia diversion[37]
- Difficulties with fume investigations of Ryanair's Boeing 737[38]
- Ground crew "sucked" into an Air India's aircraft engine[39]
- Tug caused Southwest nose gear snap on B737-300[40]
- Smoke event involving Airbus A380[41]
- Near loss of A330 due to positioning of captain's personal camera[42]
- Confusion over power setting key factor in Emirates B777 crash[43]
- USAF spreads blame for fatal WC130h crash[44]

4.10 Physical reality: Maintenance induced failures

4.11 Physical reality: Reliability is dependent on natural environment

- Hailstorm damaged B787 during climb causing return back to China[45]
- Unfavourable winds delay test flight of NASA's low-density supersonic demonstrator[46]
- Rat on plane forces Air India flight to return to Mumbai[47]
- Elevator malfunctions in MD-83's rejected takeoff[48]
- Lightning strikes caused power cut on National Grid in UK[49]
- Plastic sandwich bag caused retirement of Williams F1 car in Melbourne[50]
- Northeast Airlines cancelled 1,900 U.S. flights due to storm

4.11.9 Impact of bird strikes on aircraft reliability[51]

5.12 Closing remarks regarding physical reality of reliability

6. Mathematical versus physical reality of reliability

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Base on the information provided thus far it is possible to summarise that there are clear differences between a mathematical reality of reliability and the observed physical reality of reliability described through observed reliability related events described in the text. The major points of the differences between them are presented in the Table 2.

Mathematical Reality	**Physical Reality**
Quality of produced components and assemblies is hundred percent	Quality of produced components and assemblies is less than hundred percent
Errors during system transportation, storage and installation tasks are zero percent	Errors during system transportation, storage and installation tasks are greater zero percent
There is no interactions between “independent” components	There are a huge interactions between “independent” components
Maintenance activities like: inspections, repair, cleaning, etc., do not exist	Maintenance activities like: inspections, repair, cleaning, etc., exists
System and all components operate continuously (24/7)	Neither system not all components operate continuously (24/7)
First observable failure is a failure of a system	First observable failure is not necessarily the failure of a system
Components and a system have the same “times”	Components and a system have different “times”
Fixed operation scenario (load, stress, temperature, pressure, etc.)	Variable operation scenario (load, stress, temperature, pressure, etc.)
Reliability is independent of the location in space defined by GPS coordinates	Reliability is dependent on the location in space defined by GPS coordinates
Reliability is independent of humans	Reliability is dependent on humans
Reliability is independent of maintainers	Reliability is dependent on maintainers
Reliability is independent of calendar time	Reliability is dependent on calendar time
Reliability is independent of environment	Reliability is dependent on environment

Table 2: Comparison between mathematical and physical reality of reliability

7. Closing Question

The main objective of this text was to expose the reliability and safety community to the mathematical and physical realities of the reliability function with the objective to focus their attention to the following question, “*What is the body of knowledge on which reliability and safety modelling should be based, in order for the predictions made to be confirmed by reliability measures obtained in operationally defined physical reality?”*

8. Acknowledgement

The author wishes to acknowledge that the majority of the information regarding the reliability and safety events presented in this text originated from the Aviation Weekly[52].

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[52] www.aviationweekly.com

Also, the author wishes to acknowledge the contribution of the numerous students, at Exeter University (1986-1999) and the MIRCE Akademy (1999-current), towards his endeavour to understand the physical mechanisms that cause occurrences of failure events through the collection and analysis of information related to the in-service behaviour of functionable systems, as the only way towards the creation of the modelling method that would provide predictions of reliability and safety which are confirmed by measurements obtained in the operationally defined physical reality, as it is achievable in mechanical, electrical, chemical, nuclear and other branches of engineering.

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