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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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MIRCE Science

According to Knezevic [1] 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 in-service life of functionable systems is frequently beset by undesirable negative functionability events, resulting from a variety of negative functionability actions (overstress, wearout, natural events, and human interventions). For the work to be continued, positive functionability actions, (servicing, repairing, testing, replacing, changing the mode of operation and similar) must be performed on the system. Thus, the complex interactions between positive and negative functionability actions govern the functionability performance of functionable systems, primarily measured through work done and resources consumed expressed through monetary values (functionability cost).

Regrettably the functionability performance becomes known only at the end of the life of functionable system[2], when nothing could be done to influence it. Hence, the ability to accurately and quantitatively predict functionability performance of the future functionable systems at the design stages, when all possible changes could be done, would be invaluable for all project: engineers, planners, managers and strategist. The mixture of technical systems and management methods chosen to govern the behaviour of functionability systems through time uniquely determine the expected: functionability work, cost and the expected return on the investment (profit, public benefit, reputation and so firth).

Five decades of research conducted by Knezevic [1] have generated a theoretical body of knowledge, named MIRCE Science, which comprises of axioms, system of formulas and methods that enable predictions of functionability performance of the future functionable systems to be done, by the modelling complex interactions between: physical properties of consisting components, operational rules, maintenance policies, support strategies and expected environmental conditions.

MIRCE Science is based on the scientific understanding of the 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). [1] These mechanisms, together with the applied human rules, shape the expected pattern of the motion of a functionable system through MIRCE Space[3]. The "normalised" life-long pattern expected to be generated by each feasible type of functionable system is predictable, from the early stages of the design, by making use of the

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[1] Functionable system is a well defined collection of atomic, natural and human elements put together to do functionable work.[]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, and the probability of being in that state at each instance of calendar time. [1]

MIRCE Functionability Equation, which is the bedrock for the calculation of 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

Minimum Equipment List as a Mechanism of Motion in MIRCE Mechanics

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Abstract

To avoid the loss of consumer trust, revenue or capability any disruption to a system's functionality is unacceptable to the providers, on one hand and also to their receivers, on the other. Consequently, every effort must be made to ensure the continuity of the provision of the system's functionality through calendar time. One of the methods used to minimise disruption to operational capability, especially in the aviation industry, was the creation of the Minimum Equipment List (MEL). This list identifies the equipment/components present into system that are not necessary to be operational for the safe provision of the functionality of the system, in accordance with the prescribed operational and maintenance restrictions, and approved by the regulatory authorities. Consequently, the main objective of this paper is to present the concept of the MEL as one of the potential mechanism to be used outside aviation community to further influence the motion of a functionable system type through MIRCE Space and potentially enhance its functionability performance as perceived by MIRCE Science.

Post-Maintenance Flight Test as a Mechanism of Motion in MIRCE Mechanics

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Abstract

MIRCE Mechanics is a part of MIRCE Science that focuses on the scientific understanding and description of the physical phenomena and human rules that govern the motion of functionable system types though MIRCE Space[1]. A full understanding of the mechanisms that influence this motion through MIRCE Space is essential for accurately predicting the functionability performance of functionable system types using MIRCE Science. According to the 5th axiom of MIRCE Science, the probability that a completed maintenance task introduces faults or errors is greater than zero. To reduce the probability of introducing undetected maintenance errors and their consequential impact on the system operational process, the concept of the Post-Maintenance Flight Tests (PMFT) is used in aviation industry. Consequently, the main objective of this paper is to critically assess these types of maintenance verification tests and their impact efficacy on the functionability performance, as understood through the application of MIRCE Science. The physical reality of inducing errors during maintenance and their consequences on post-maintenance flight is illustrated using an incident that regrettably took the lives of two pilots, when their Piper PA 46-350P, N962DA, crashed into the Spokane River on May 7, 2015, following an attempted landing at Felts Field Airport in Spokane, Washington, USA.

Lightning Strike as a Mechanism of a Motion of an Aircraft through MIRCE Space

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Abstract

MIRCE Science is a theory for predicting expected functionability performance for a functionable system type. For accurate predictions to be made it is essential for the generic random variables contained in MIRCE Functionability Equations to be "physicalised", for each functionable action that impacts in-service behaviour of functionable system type considered. It requires a science-based understanding of the mechanisms that govern the occurrences of negative functionability events before engineering, technological, business and economical decisions are made. Lightning strikes are not uncommon physical mechanisms that cause the motion of functionable systems type through MIRCE Space. For example, airliners in the worldwide fleet average at least one strike per year. Hence, the main objective of this paper is to understand physical mechanisms that generate the occurrences of lightening events and assesses their impacts on the functionability performance of functionable systems types, as well as to assess the available methods for dealing with them in respect to the provision of safety by detection, protection and design.

Vibration Measuring as a Mechanism of Managing the Motion of a Gearbox through MIRCE Space

Sylvester James, The Seasoned Analyst, Bristol, UK

Abstract

MIRCE Science is a theory for predicting expected functionability performance for a functionable system type. Accuracy of the predictions is governed by the degree of the scientific understanding of the mechanisms that generate positive and negative functionability actions, which govern the motion of functionable system types though MIRCE Space. The main objective of this paper is to address vibration measuring as one of the possible mechanisms chosen by humans to manage the functionability work done by a gearbox. This process is illustrated by a case study related to heavy gearbox used in Plastics manufacturing industry, conducted by the author with vibration data collected on site by Ian Graham (The Seasoned Analyst).

Precision Alignment as a Mechanism of the Motion of Rotating Machines through MIRCE Space

Sylvester James, The Seasoned Analyst, Bristol, UK,
Pearce James, The Seasoned Analyst, Bristol, UK
Knezevic Jezdimir, MIRCE Akademy, Exeter, UK

Abstract

MIRCE Science is a theory for predicting expected functionability performance for a functionable system type. Accuracy of the predictions is governed by the degree of the scientific understanding of the physical mechanisms, and human rules, that govern the motion of functionable system types though MIRCE Space. The main objective of this paper is to address precision alignment as one of the possible mechanisms that governs motion of rotating machines trough functionability states, which are contained in MIRCE Space, In general, and to illustrate this process through a case study related to Laser alignment of a pump used in Power Generation industry, conducted by the author with vibration data collected on site by James Pearce (The Seasoned Analyst).

Fuel Tank Explosion as a Mechanism of Motion of an Aircraft through MIRCE Space

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Abstract

MIRCE Science is a theory for predicting expected functionability performance for a functionable system type. The accuracy of the prediction is governed by the extent of the scientific understanding of the mechanisms, natural and human rules, which govern the motion of a functionable system types though MIRCE Space. Thus the main objective of this paper is to analyse the mechanisms that cause the fuel tank explosion and move an aircraft from a positive to a negative functionability state. The paper starts with a brief analysis of the major fuel tank explosions that took place in commercial aviation during last 50 year. There is then a brief overview of a typical aircraft fuel system and its constituent elements, including the aviation fuel, followed by the analysis of sources and causes of the explosions in the commercial aviation fuel tanks. Also a brief description of the mechanisms that result in spark initiations due to electric effects is given in the paper. The design measures taken to preclude ignition sources from the fuel tanks are presented at the end of the paper. Finally, the paper illustrates the need for taking existing Engineering knowledge further; to enable prediction of "emerging in-service risk" earlier in the design process. For example, it is essential to link the impact of internal architecture of the aircraft (near air-conditioning units) and its location in the universe (sitting on a runway in Abu-Dhabi) with the increased risk of fuel tank explosion. That extension is provided through MIRCE Science, where the functionability phenomena is recognised, through MIRCE Mechanics, which requires understanding of all internal and external mechanisms that influence the motion of the functionable system type through MIRCE Space, into MIRCE Engineering and MIRCE Management that look at avoiding unwanted risk through engineered solutions or managing the impact of the risk as an integral part of the business plan.

MIRCE Science Based Operational Risk Assessment

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Abstract

The philosophy of MIRCE Science is based on the premise that the purpose of existence of any functionable system is to do functionability work. The work is done when the expected measurable function is performed through time. However, experience teaches us that expected work is frequently beset by the natural environment, the general population or the businesses, some of which result in hazardous consequences. Undoubtedly, the ability to accurately and quantitatively assess the risk of occurrence of these undesirable and especially those hazardous interruptions early in the design stages would be invaluable for all decision makers. Regardless of whether engineering solutions or management methods are chosen to control the risk, they will have a direct impact on the operational plan that should deliver the expected work, within the expected budget and delivering the expected return on their investment (e.g. profit or performance). For the last sixty years, Reliability Theory has been adopted to address this need. However, the efficacy of these predictions is only valid until the time of the occurrence of the first failure of a functional system. This is seldom understood and far from satisfactory where we are working with repairable or maintainable equipment and systems over their expected life. Consequently, the main objective of this paper is to demonstrate how the body of knowledge contained in MIRCE Science can be used for the assessment of the risk of occurrences of operational interruptions during the expected life of any given functionability system type. MIRCE Science is based on the scientific understanding of the mechanisms that generates the occurrences of these interruptions, considered within a physical scale between 10^{-10} *and* 10^{10} *of a metre. These mechanisms, together with the corresponding applied human rules, shape the pattern of the occurrences of these expected interruptions through what we will come to understand as MIRCE Space. The life-long pattern expected to be generated by each future functionability system type is predictable, from the early stages of the design, by making use of the MIRCE Functionability Equation, the mathematical formulation of which is presented in this paper. Some real life operational interruptions are analysed and presented in the paper as supporting evidence for the validity of performing risk assessment in accordance with MIRCE Science, which is quantifiable by the amount of functionability work that can be expected to be delivered through the life of each functionable system type.*

Ice Crystal Icing as a Mechanism of Motion of Aircraft through MIRCE Space

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Abstract

MIRCE Mechanics is a part of MIRCE Science that focuses on the scientific understanding and description of the phenomena that govern the motion of functionable system types though the functionability states of MIRCE Space [1]. A full understanding of the mechanisms that generate the motion is essential for the accurate predictions of the functionability performance of functionable system types using MIRCE Science. According to the 2nd Axiom of MIRCE Science the motion of functionable system type through MIRCE Space is a result of imposed natural phenomena or human activities, which are jointly called functionability actions Thus, the main objective of this paper is to address ice crystal formation (icing) in aircraft engines, as physical phenomena that are experienced by aircraft after prolonged exposure to an area where ice crystal concentrations are present. These are methodological conditions where strong convective weather activity lifts high concentrations of ice crystals to high altitude. The crystals can partly melt and stick to internal engine surfaces causing power loss and/or surge/stall to occur. Available data indicates that there have been at least 100 events of jet engine power loss due to core-icing during the last 30 years

How Reliable is Reliability Function?

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Abstract

According to Knezevic the purpose of existence of any functionable system is to do functionability work, which is considered to be done when the expected measurable function is performed through time. However, experience teaches us that in-service life of functionable systems is frequently beset by undesirable negative functionability events, resulting from a variety of negative functionability actions (overstress, wearout, natural events, and human interventions), some of which result in hazardous consequences to: the users; the natural environment; the general population and businesses. During the last sixty years, Reliability Theory has been used to predict occurrences of negative functionability events. However, mathematically and scientifically speaking, the accuracy of these predictions, at best, were only ever valid to the time of occurrence of the first failure, which is far from satisfactory in the respect of its expected life. Consequently, the main objective of this paper is to raise the question how reliable are reliability predictions based on the Reliability Function.

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