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2016 Annals of Mirce-mechanics

"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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[1] Paper was presented at the 22 International Conference "Maintenance 2016", in Sibenik, 16-18 May 2016, Croatia, organised by the Croatian Maintenance Society, www.hdo.hr

Mirce-mechanics

The philosophy of Mirce-mechanics is based on premises that the purpose of existence of machines is to do a work by delivering intended function(s) thought time, like transporting, communicating, cooling, informing, computing and others with measurable performance, like speed, capacity, frequency, power and similar physical quantities. However, experience teaches us that in-service life of machines is dominated by complex interactions between their consisting parts on one hand and their interactions with natural environment and human actions, on the other. As result a variety of mechanical, electrical, chemical, thermal, radiant and other types of energy are generated, some of which causing failures of machines to deliver intended function(s). Actions like servicing, repairing, testing, replacing, changing the mode of operation and similar that are required to regain functionability[2] of machine. Hence, in Mirce-mechanics a machine with associated in-service tasks, resources, constraints and environmental conditions constitute a maintainable system, which is ultimately and uniquely responsible for delivering functionability performance of a machine.

As all physical phenomena associated with the functionality of machines are characterised by certainty, reversibility and independence of time, location and human influences, their functionality performance can be accurately predicted by making use of well understood laws of natural sciences, such as: Newton's laws of motion, Maxwell's law of electrodynamics, Coulomb's law of solid friction, Boltzmann's law of thermodynamics, Hook's law of stress and strength, to name a few. However, the information regarding functionability performance of a machine within a given Mirce-system is almost non-existent at the beginning of in-service life. The reason being, all associated functionability phenomena are characterised by uncertainty, discontinuity, irreversibility, inseparability, and are dependent on time, location and human influences, Hence, the laws of natural sciences cannot be used to predict functionability performance of a maintainable systems in Mirce-mechanics.

To address rationally essential questions of the accurate predictions of functionability performance of machines in 1999 Dr Jezdimir Knezevic resigned from Exeter University, UK, and established the MIRCE Akademy at Woodbury Park, Exeter, UK. Staff, Fellows, Members and students of the Akademy have endeavoured to subject in-service behaviour of a maintainable systems to the proven methods of science and mathematics to:

1. Experimentally observe and measure their functionability performance of maintainable systems that are quantified through the work done by a system and the work done on a system throughout in-service life, together with the resources consumed in these processes[3], and prevailing environmental conditions, to determine their patterns in respect to time.
2. Scientifically understand physical phenomena that govern occurrences of functionability events[4] through life of a given maintainable system to the level of the dimensional fidelity ranging from the atom (10^{-10} metres) to the Solar System (10^{10} metres).

[2] Functionability, n. ability to deliver intended function, Knezevic, J., Reliability, Maintainability and Supportability – A probabilistic Approach, Text and Software package, pp. 291, McGraw Hill, London 1993. ISBN 0-07-707691-5

[3] Boeing 747, registration number N747PA, been air born 80,000 flying hours, transported 4,000,000 passengers, burned 271,000,000 gallons of fuel while receiving 806,000 maintenance man-hours and consuming: 2,100 tyres, 350 brake systems, 125 engines, among other parts, during the 22 years of in-service life, at Pan Am airlines.

[4] Any event, natural or induced, that impacts the functionability performance of maintainable systems.

3. Mathematically define a scheme for calculating expected functionability performance for a given maintainable system (uniquely determined by the physical properties of consisting parts and their configurations) within a given operational scenario, environmental conditions, maintenance policies, support strategy and in-service constraints.

Decades of research has generated new, science-based, body knowledge, named Mirce-mechanics. It comprises of axioms, laws, mathematical equations and calculation methods that enable accurate descriptions of functionability phenomena that are characterised by uncertainty, discontinuity, irreversibility, inseparability, and dependence on time, location and humans. Thus, Mirce-mechanics enables accurate predictions of the expected functionability performance of a given maintainability system, at the time when it is possible to achieve the best compromise between all feasible solutions and stake holders.

Volcanic Ash as a Mechanism of a Motion in Mirce-mechanics

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Abstract

Mirce-mechanics is a scientific theory of the motion of in-service systems through Mirce Spacetime that enables prediction of the work done by them to be made by using Mirce Equations. Practical applications of Mirce-mechanics are possible only, when the physical mechanisms that generate the motion of systems through positive and negative states of Mirce Spacetime are understood. The mechanism of motion addressed in this paper is the impact that volcanic ashes made on the trajectory of maintainable systems through Mirce Spacetime. Volcanic ash fall is physically, socially and economically disruptive. It can affect both proximal areas and areas many hundreds of kilometres from the source, and causes disruptions and losses in a wide variety of different infrastructure sectors. Impacts are dependent on: ash fall thickness; the duration of the ash fall; the grain size and chemistry of the ash; whether the ash is wet or dry; and any preparedness, management and prevention measures employed to reduce effects from the ash fall. Specific emphasis is this paper is given to the analysis how different sectors of infrastructure and society are affected in different ways and are vulnerable to a range of impacts or consequences.

Maintainability Design Principles for Aircraft Maintenance Error Avoidance

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Abstract

There has long been a philosophy in aircraft design that errors by maintainers are not the concern of the designer – maintainers should be trained not to make errors. That philosophy is rapidly changing. There is an increasing awareness by regulators, designer/manufacturers, operators and other organisations in the aircraft industry of the impact that the design characteristics of aircraft can have on safe and effective maintenance performance and, in particular, on the avoidance of maintenance error and the mitigation of its consequences.

Designers of aircraft, systems and components cannot influence all of the many factors that might influence maintenance performance and maintenance error. However, designers have an important role to play because design characteristics have a significant impact on the form, frequency and duration of the maintenance task and have important implications for the possible occurrence of maintenance error.

From a design perspective, there are a number of complementary and integrated strategies that can be adopted to effectively address the relationship between design characteristics and maintenance error including – i) to specify design requirements for aircraft, system and component design that directly address the possibility of maintenance error, ii) to integrate into design general principles that can be applied by the aircraft, system or component designer to assist in them in designing to prevent maintenance error or, if this is not practicable, to reduce its negative effects, and iii) to analyse design solutions for maintenance error through formal evaluation processes such as human hazard or human error analyses.

This paper examines the second of these strategies. It identifies and discusses the rationale of general design principles that can be adopted by designers as part of an overall design effort for maintenance performance.

It is based on the author's experience in developing design principles for maintenance performance and in developing and delivering practical training for designers of commercial aircraft.

Durability Driven Logistics Demand Analysis

J. Knezevic
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Abstract

Accurate selection of the quantity of logistic support resources has a strong influence on mission success, system availability and the cost of ownership. At the same time the accurate prediction of these resources depends on the accurate prediction of the durability measures of the items involved. This paper presents the method for the advanced and accurate calculation of the durability measures of complex space systems which are the basis for the determination of the demands for logistics resources needed during the operational life or mission of space systems. The applicability of the method presented is demonstrated through several illustrative examples.

Determination of Operations Down Time for Group Replacement Maintenance Policy

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Abstract

Prediction of the duration of the down time caused by maintenance, especially in the cases where system considered consists of several repairable items, presents a challenge for maintenance managers, because of possible revenue losses during these intervals of time. The paper responds to this challenge through the new methodology for the fast and accurate prediction of maintainability measures related to the group replacement maintenance policy. It is applicable to group maintenance tasks whose comprising of individual replacement tasks are performed: simultaneously, sequentially, and combined. The method presented could be successfully used at the planning stage of operations process when the information available is based on previous experience only, as well as, at the stage when process is performed. The applicability and usefulness of methodology proposed is demonstrated through an illustrative numerical example

Increasing Profitability and Reliability through Failure Management

Jezdimir KNEZEVIC, MIRCE Akademy, Exeter, UK

***Abstract*:**

Commonly, maintenance is perceived as "fixing broken things". As such, it is associated with failure consequences and unplanned expenses, both of which negatively impact business plans or customer satisfaction. However, as failures are an inevitability of the life of any technological system, it would be worthwhile to start looking at maintenance as opportunity for dealing with them and making t positive impact on business plans or customer satisfaction, by generating profitability and reliability. Thus, the main objective of this paper is to present the Mirce-mechanics approach to maintenance that is focused on the way that failures, once scientifically understood, could be managed in the way that reduces the number of in-service interruptions and operational costs, which in turn will generate profit for private companies or increases the reliability for public services like health, transportation, tourism up to the national defence.

Wear Check Oil Diagnostics: Way to Improve Machine Health by Condition Monitoring[5]

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Tonća Ćaleta Prolić, MIng Chem. INA Maziva d.o.o, Radnička cesta 175, Zagreb, Croatia

Abstract:

A well run condition monitoring program can achieve significant benefits in operational reliability of machinery. According to a study by Dr. Rabinowicz of MIT, 70% of component replacements are due to wear and corrosion which are strongly related to lubrication and condition monitoring practices. The paper shows the WearCheck oil and wears particle analysis system as the tools to manage a condition monitoring program for lubricated systems. It can save money by maximizing oil change interval potentials and by detecting the ingress of contaminants from the operating environment as well as the abnormal changes in oil and component wear due time. Early warning by recognizing such changes leads to saving the oil and avoiding excessive wear. Primary goals of oil analysis are to support predictive and proactive maintenance.

[5] Paper was presented at the 22 International Conference "Maintenance 2016", in Sibenik, 16-18 May 2016, Croatia, organised by the Croatian Maintenance Society, www.hdo.hr

The shape of things to come: The way we used to predict In-service Reliability of new Equipment.

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ABSTRACT:

For many years military programmes have used constant failure rate to model reliability of the new electronic equipment designs. They re-enforced this constant model by measuring achieved performance by dividing the number of failures by the unit of operation (hour/landing etc.). In parallel, Companies and Customers acknowledged that "predicted" reliability was unlikely to be achieved from day one in service. So, we included a "fudge factor" or perhaps even a reliability growth profile. These profiles, often based on historical performance or "best engineering judgement", are applied to the failure rate prediction to provide a "more realistic indication" of the real in-service reliability. This paper describes the surprising differences I found in the financial or operational risks we accept by trying to "fudge" a constant failure rate model to address the reality of how the different identifiable and definable failure mechanisms will contribute to the "real" failure profile of new equipment

Mirce Profitability Equation

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ABSTRACT

Commonly, maintenance is perceived as "fixing broken things". As such, it is associated with failure consequences and unplanned expenses, both of which negatively impact business plans or customer satisfaction. However, as failures are an inevitability of the life of any technological system, it would be worthwhile to start looking at maintenance as opportunity for dealing with them and making t positive impact on business plans or customer satisfaction, while generating profit. Thus, the main objective of this paper is to present the Mirce-mechanics approach to maintenance that is focused on the way that failures, once scientifically understood, could be managed in the way that reduces the number of in-service interruptions and operational costs, which in turn will generate profit for private companies or increases the effectiveness of public services like health, transportation, tourism up to the national defence. Finally, the development of the Mirce Profitability Equation has been presented in the paper, which is the bed rock of this approach.

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Prognostic Engineering Science
- the attributes of decay that affect functionability-

Chris Burden BSc, MINDT, Science Fellow MIRCE, Director AePS.

Abstract

Condition monitoring of engineered operational products/systems has been a life time career for me. Having commenced employment in September 1971, starting as a 16 year old engineering apprentice by Rolls-Royce (1971) Defence Engine Division at Bristol through 43 years in the same company seriously involved in product measurement engineering, I hold enormous knowledge of the 'science' discipline.
I have completed an engineering apprenticeship with a Higher National Certificate in Engineering followed by a personal Technology/Science education through the Open University. These educations and operations started the association of how many engineered products with a different operational analysis can map to an understanding of how functional decay can be detected and understood.

My vision for condition monitoring, as the human race advances in science and requirements for the future, is that it will be absolutely essential that a discrete condition/health monitoring system integrated into the product/system as a prime consideration of the product/system design, is not treated as an 'add on', as currently considered.

The decay in the operation of an engineered product/system will gradually affect the functionability of the product/system and consequently start to define the probability routes to an ultimate failure mode manifestation. However the definitions for the probability routes that lead to the failure modes are far more complicated than expected, envisaged and perhaps understood and these issues I hope to express in this document for prosperity.

*For example, one of the key witnesses to a failure mode probability route maturing is the '**increase'** in ascertainable 'change' 'seen' and reported in the monitoring of the operational device, by for example a vibration transducer.*

*In vibration monitoring the most common understanding is that an 'increase' in monitored vibration levels point at the 'operational functionability change' and define the precursory view of decay onset, commencing the countdown to system ultimate failure. This is not necessarily the case as 'elastic stress' wave sensors can/do experience a '**decrease'** in the signature levels as the functionability changes, let's explore, within the realms of the title Condition Monitoring.*

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