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2014 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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Exeter
EX5 1JJ
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Phone: +44 (0) 1395 233 856
Email: quest@mirceakademy.com
Website; www.mirce.com

Editor:
Dr J. Knezevic, President MIRCE Akademy

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Mirce Mechanics

According to Einstein **"***Everything that the human race has done and thought is concerned with the satisfaction of felt needs*".

During the history of civilisation needs for transporting, communicating, navigating and many others have been satisfied by transpiration, communication, navigation and other human created systems. The mechanics of the functioning of maintainable systems are well-understood processes, which are predictable by the laws of natural sciences, such as: Newton's laws of motion, Coulomb's law of solid friction, Hook's law of stress and strain, Maxwell's law of electrodynamics, Boltzmann's law of thermodynamics, to name a few.

Needs satisfying systems are constructed by assembling a well-defined number of parts in a precise and preestablished way. As they are functioning in predetermined linear chains of cause and effect, their performance measured through speed, acceleration, power, range, energy usage, capacity and similar is also predictable. The reason for the predictability of the system design-in functionality performance is the fact that they are based on the physical and chemical processes that are characterised by certainty, continuity, reversibility, separability and independence of time, location and humans.

Regarding the long-term satisfaction of human needs, the ability of a system to function beyond the delivery day is an essential property of its in-service performance. Due to complex interactions between consisting parts and impacts from environment and humans, disturbances of mechanical, electrical, chemical, thermal, radiant and other types are created, some of which cause occurrence of events that prevent systems from functioning. Thus, to provide the flow of functionality through time maintenance tasks like servicing, repairs, overhauls, replacements and similar are undertaken by humans, making them maintainable systems. Thus, from the point of view of the ability to function during the in-service life, known as f**unctionability**[1]**,** maintainable systems could be in a positive or a negative functionability state, at any instant of time.

Experience teaches us that unlike quantitative information regarding the design-in functionality performance of a system that is available on the delivery day, the in-service functionability performance is not. Instead, years later the statistics for various functionability measures become available. The reason for this is the fact that they are emerging properties of the complex interactions between system in-service processes, which are characterised by indeterminism, discontinuity, irreversibility, inseparability, and dependence on time, location and humans.

To scientifically understand processes and mechanisms of the motion of maintainable systems through functionability states during in-service life resulting from any causes whatsoever and to develop laws and rules that enable predictions of emerging functionability trajectory to be made in 1999 Dr Knezevic established the MIRCE Akademy at Woodbury Park. Staff, Fellows, Members and students of the Akademy study in-service behaviours of maintainable systems to:

- Determine the patterns of the motion of functionability through the life of maintainable systems and to measure emerging functionability properties.
- Understand mechanisms of the motion of functionability through the life of maintainable systems, within the physical scale from 10^{-10} to 10^{10} metre,
- Define the mathematical scheme for the prediction of emerging functionability measures for a given: maintainable system in a given in-service conditions.

A generated body of scientific knowledge constitutes Mirce Mechanics whose axioms, formulas, methods and rules enable predictions of the emerging functionability trajectory of the future transportation, communication, navigation and many other maintainable systems to be made.

[1] Knezevic, J., Reliability, Maintainability and Supportability – A probabilistic Approach, Text and Software package, pp. 291, McGraw Hill, London 1993. ISBN 0-07-707691-5

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Mathematical Principles of Mirce Mechanics

Dr Jezdimir Knezevic
MIRCE Akademy, Woodbury Park, Exeter, EX5 1JJ, UK

Abstract

Scientific principles and concepts expressed through the laws, equations and formulas are the bedrock for the prediction of the deign-in functionality performance of any engineering creation. However, there is no equivalent when the in-service functionability performance predictions have to be made. Hence, Mirce Mechanics has been created at the MIRCE Akademy to fulfil the roll. The main purpose of this paper is to present the development and application of mathematical principles of Mirce Mechanics that is the bedrock for the prediction of the functionability performance of maintainable systems.

Applied Genetic Programming in a Chemical Plant for Reducing Production Costs

Ariel Katz, Centre for M.I.R.C.E., University of Exeter, U.K.

Abstract

The Genetic Algorithms (GA) is a model of "machine learning", Goldberg (1985,1989). Whereas classical optimisation methods often rely on a local gradient search, a genetic algorithm keeps track of the population of potential solutions. It is thus less sensitive to an arbitrary initial guess of the solution, which imparts it with a degree of protection from the local optima trap. The GA is a model of machine learning, which derives its behaviour from a metaphor of the processes of evolution in nature. This is done by the creation within a machine of a population of individuals represented by chromosomes, in essence a set of character strings that are analogous to the base - 4 chromosomes that we see in our DNA. The individual in the population then goes through a process of evolution. A genetic algorithm is a trial and error process whose method of producing solutions imitates biological evolution and allows an improvement in the solution. The genetic algorithm has been tested on a variety of problems e.g., a model of an industrial flowability, customer service pH controls system etc.

Paper presented at 9th MIRCE International Symposium, 1-3 December 1999, Exeter, UK

Space Weather as a Mechanism of the Motion in Mirce Mechanics

J. Knezevic, MIRCE Akademy, Exeter, EX5 1JJ, UK

Abstract

The main objective of this paper is to draw attention to the Mirce Mechanics approach to reliability and safety of maintainable system, which enables accurate predictions of the motion of functionability through their in-service lives to be made by design engineers. This paper focuses on the scientific understandings of the space weather phenomena as mechanisms of the motion of functionability through the life of systems like power networks, aviation, satellite services, pipelines, digital control systems and similar.

Hospital Logistics

Mikko R. Salminen, Jyvaskyla Polytechnic,
School of Engineering and Technology, Jyvaskyla, Finland

Abstract

There has been a lot of discussion about hospital logistics. So far there have been no definitions for that area. Also all the articles under this topic have handled only some single elements of hospital logistics without a wider context. This article is made in order to find and define the essence and the scope of hospital logistics. By doing so this article should establish a foundation for further research in the area of hospital and health logistics.

Paper presented at 12th MIRCE International Symposium, December 2002, Exeter, UK

Bird Strike as a Mechanism of the Motion in Mirce Mechanics

Dr J. Knezevic, MIRCE Akademy, Exeter, UK,

Abstract

Birds represent a serious, but often misunderstood, threat to aircraft. Most bird strikes do not result in any aircraft damage, but some bird strikes have led to serious accidents involving aircraft of every size. According to Bird strike Committee USA, bird and other wildlife strikes to aircraft result in over $600 million in damage to U.S. civil and military aviation each year. The lives of the crew and passengers are also at risk. Since 1988, over 200 people have been killed worldwide as a result of encounters with birds and other wildlife. Thus, this paper addresses bird strike from Mirce Mechanics point of view, which means that it is considered as a mechanism that generates a functionability event which causes the motion of a system from positive to negative functionability state. The paper provides vital information about the physical properties of most common birds that are required for predictions of their impacts on aircrafts, at the design stages as a scientific method for the evaluation of alternatives.

Efficient Learning of Failure Detection, Understanding and Prevention: Case Trial Bike

Pasi Lehtola and Juha Sipilä, Jyvaskyla University of Applied Sciences, Finland

Abstract

Authors lectured this spring a course titled Supportability Analysis and Design for a group of about 20 second-year engineering students in Jyvaskyla University of Applied Sciences. The course aimed at showing how various logistic support analyses help the engineers to improve design, maintenance and support of systems while keeping the life cycle cost at a reasonable level. These analyses included elements of reliability theory; failure identification methods; failure rate calculations; criticality estimations; availability, maintainability and safety issues; reliability centred maintenance topics; level of repair analysis; and cost calculation. To bring the theory into practice we presented a case study.

Presentation made at 1st MIRCE International Symposium of Understanding Machine Failures, June 2007, Exeter, UK

Possible Approach to Reliability Prediction with Strength Degradation Process

Zeljkovic Vladimir,
LOLA Institute, Kneza Viseslava 70a, Belgrade, Yugoslavia

Abstract

In this paper, the reliability model is analysed. The strength is described as degrading process. The stress is considered as static or Poisson process. Probability of failure is obtained by general stress-strength interference. The reliability, as probability of surviving given time interval, is derived as function of instantaneous probability of failure. Numerical examples are calculated for different (Weibull and normal) distributions of strength and stress, and for static and Poisson load.

Paper presented at 9th MIRCE International Symposium, 1-3 December 1999, Exeter, UK

Mirce Mechanics Analysis of the Flight 1549

J. Knezevic, MIRCE Akademy, Exeter, EX5 1JJ, UK

Abstract

The main objective of Mirce Mechanics is the understanding of mechanisms that generate positive and negative functionability events, which cause the motion of a system through corresponding functionability states. Hence, this paper addresses the mechanism of the collision between birds and flying objects, commonly know as a bird strike. This is typical example of the overstress mechanisms where a huge amount of kinetic energy is generated by the collision of both flying objects. Consequently, the main purpose of this paper is to analyse mechanisms of the motion of the USAir A320 through functionability states caused by the kinetic energy generated by the collision with a flock of Canadian Geese during the flight 1549, on 15th January 2009, in New York. The consequences of the motion on the fuselage and engines are analysed and presented here.

Life-Cycle Benefit of Repair

Adrian Blenkiron, Rolls Royce, Filton, UK

Abstract

During the concept, design and development phases of a project, the role of the Logistics Support Department is to influence the product design for supportability and originate support systems optimised for life cycle benefit. The support system's task is the management of the effects of product failure. To ensure that the Logistic Support department fulfilling its role it is essential that each aspect of the support system is providing maximum life cycle benefit. This paper investigates the operation of the repair system with regard to life cycle benefit.

Paper presented at 9th MIRCE International Symposium, 1-3 December 1999, Exeter, UK

When “if it ain’t broke, don’t fix it may not be the best policy

John Crocker,
Science Fellow of the MIRCE Akademy

Abstract

It is the fate of almost every system made by man to eventually wear out or outlive its usefulness. Most high-value systems are designed to be repairable such that if parts of the system cease to perform their designated function adequately, they can either be returned to a state of functioning or replaced without having to discard the whole system. For these systems, waiting until they fail is seldom the most cost-effective policy. Unfortunately, few failures can be predicted with very much confidence or precision. This paper proposes an opportunistic maintenance policy that attempts to reach a compromise between the conflicting desires to maximise the times between maintenance actions whilst minimising the in-service support costs.

System Engineering - Can reality prediction be made as accurate as in Physics?

Professor Arie Dubi
Department of Nuclear Engineering
Ben Gurion University of the Negev, Beer-Sheva, Israel.

Abstract

System Engineering involves, basically, prediction of the future behaviour of systems. One wishes to answer questions such as: What would the reliability, availability and other performance measures of the system be? How many spare parts, repair teams, Inspections, Maintenance operations of all kinds and other resources be allocated for the system so as to guarantee a required performance level at a minimal cost? etc. The purpose of this paper is to discuss the framework under which such predictions can be made. It will be demonstrated that a general system transport equation exists which governs the system behaviour. The prediction process can be most effectively performed using the Monte Carlo method for the solution of the transport equation.

Paper presented at 12th MIRCE International Symposium, December 2002, Exeter, UK

Opportunistic Maintenance in Aircraft using Relevant Condition Parameter based Approach

Dr Haritha Saranga
Indian Institute of Management Calcutta, P O Box 16757, Alipore (Post)
Calcutta 700 027, INDIA

Abstract

Opportunistic maintenance has been an essential part of all systems-maintenance, implicitly if not explicitly. However, as systems become more expensive and complex, the decisions involving opportunistic maintenance activities become more challenging. In this paper, we discuss a few issues that arise while carrying out the opportunistic maintenance, and try to resolve them with the help of a popular optimisation technique called Genetic Algorithms. We also present a few results concerning relevant condition parameter based maintenance, as it has a high potential to be an opportunistic maintenance in complex systems. A systematic methodology is designed to enable the maintenance crew in deciding which items to be maintained when an opportunity arose. The cost of premature replacement is compared with the cost of down time, in the optimisation process using Genetic Algorithms.

Paper presented at 11th MIRCE International Symposium, December 2001, Exeter, UK

MAINTENANCE EFFECTIVENESS – THE HIDDEN COSTS

Wg Cdr CJ Hockley OBE CEng MRAeS RAF (Rtd)
EPSRC Centre for Through-Life Engineering Services (TES),
Cranfield University, Bedford, UK

Abstract

Maintenance managers like to think that they are both efficient and effective and that their organisation is performing at its best. Initiatives come and go and some may help but some are often merely window dressing. Managers may be proactive in reducing waste in their organisations whether it is waste of resources, waste of time or waste of effort. However, to be the most successful organisation in any field requires an admission that there is always room for improvement and that there is probably still waste that remains to be identified; sometimes depending on the type of waste identified or perceived to remain, many middle managers will be reluctant to admit there are still problems to tackle. Admitting where the waste is and what needs to be done requires many things to come together. Identification of the waste and the hidden costs that result must be done though and a major area of waste that many organisations either do not recognise, or are unwilling to tackle, is the problem of No Fault Found (NFF). Using a benchmarking tool developed by the EPSRC TES Centre, is a vital first step that allows the organisation to focus on the hidden costs of NFF.

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