

## Publication of the MIRCE Akademy



# 2017 Annals of MIRCE Science

*“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**

**Publication Date:** 31 December 2017

**Publisher:**

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	<b>MIRCE Akademy Members:</b>	<b>Free of charge</b>

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## MIRCE Science

The philosophy of MIRCE Science is based on the premise that the purpose of existence of functional systems is to do a work, which is perceived as delivering of function through time, like transportation, communication, computation, protection, and others, with measurable functionality performance, like speed, capacity, frequency, power and similar physical properties. As all physical phenomena associated with functionality performance are characterised by certainty, reversibility and independence of time, location and human influences, it can be accurately predicted, at the design stage, by applying known 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.

While doing the work, functional systems are exposed to complex interactions between their consisting parts on one hand and the impacts of 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 affecting the ability of systems to function, known as functionability<sup>1</sup>. Hence, actions like servicing, repairing, testing, replacing, changing the mode of operation and similar must be performed on functional systems to enable them to continue doing the work. Experience teaches us that the information regarding functionability performance of functional systems, namely the amount of work<sup>2</sup> done by and on the system and the resources used for both, is almost non-existent at the beginning of their 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 known laws of natural sciences cannot be used to predict functionability performance of functional systems.

To seek the body of knowledge that enables the accurate predictions of functionability performance of future functional systems to be made, at the design stage when it is possible to achieve the best compromise between competing solutions, rather than to wait for the users to measure functionability performance, Dr Jezdimir Knezevic resigned from the Research Centre for Managing Industrial Reliability, Cost and Effectiveness, MIRCE, at Exeter University in UK, in 1999, to 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 functionable systems<sup>3</sup> to the proven methods of science and mathematics to:

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<sup>1</sup> Functionability, n. ability to deliver expected 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

<sup>2</sup> Boeing 747, registration number N747PA, been air born 80,000 hours, transported 4,000,000 passengers, burned 271,000,000 gallons of fuel while receiving 806,000 man-hours of maintenance 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.

<sup>3</sup> Functionable system constitutes of a functional system and the set of the rules that govern associated functionability processes, responsible for delivering functionability performance

1. Physically observe and measure their functionability performance that are quantified through the work done by a functionable system (positive) and the work done on functionable system throughout in-service life (negative), together with the resources consumed in these processes, to determine the patterns of their behaviour in respect to time.
2. Scientifically understand physical phenomena and human actions that govern occurrences of functionability events<sup>4</sup> through life of functionable system types to the level of the dimensional fidelity ranging from the atom ( $10^{-10}$  metre) to the Solar System ( $10^{10}$  metre).
3. Mathematically describe the observed physical processes of doing positive and negative functionability work through time by a given functionability system, which are characterised by uncertainty, discontinuity, irreversibility, inseparability, and dependence on time, location and humans.

Decades of research have generated a theoretical body of knowledge, named MIRCE Science, which comprises of mathematical equations and computational methods that enable predictions of functionability performance of a given functionability system to be done, at the design stage, driven by: the physical properties of functional systems, given rules (related to the operational scenario, environmental conditions, maintenance policies, support strategy) and in-service constraints.

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<sup>4</sup> Any event, induced by nature or humans, which impacts the functionability performance of functionable systems.

## Physical Reality of Mirce-mechanics- Part 1: Atomic World

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### Abstract

*This paper, through three parts, provides an introduction to the Mirce-mechanics, a new discipline that studies the in-service behaviour of in-service life of maintainable systems in order to develop a scientific methods for the prediction of their functionability performance. The in-service life is viewed as a sequence of occurrences of functionability events that are taking place in the direction of time. The main argument provided here is that successful prediction can be achieved only by understanding the mechanisms that drive physical processes, which generate the occurrence of functionability events. It is author's strong conviction that the understanding of those processes must be placed within the physical scale that will provide adequate level of fidelity. That scale is ranging from the size of Atomic System ( $10^{-10}$  metre) and by the Solar System ( $10^{10}$  metre) on the other. Analysis and research performed in any "smaller scale" would not give the fidelity of observations which could lead to prediction errors. Part 1, is focussed on the fundamental aspects of atomic world and its impact on the functionability events in the world of maintainable systems, as perceived by the author.*

## **Physical Reality of Mirce-mechanics- Part 2: Natural World**

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### Abstract

*This paper provides an introduction to the Mirce-mechanics, a new discipline that studies the in-service behaviour of in-service life of maintainable systems in order to develop methods for the prediction of their functionability performance. The in-service life is viewed as a sequence of occurrences of functionability events that are taking place in the time domain. The main argument provided here is that successful prediction can be achieved only by understanding the mechanisms that drive physical processes, which generate the occurrence of functionability events. In this paper the mechanisms that cause the occurrences of negative functionability events that originate from the natural world have been addressed and analysed. Also, the natural environment that souring most maintainable systems has been briefly analysed in order to familiarise the members of their design teams with daily natural environment of their systems. Also, the impact of that environment on the occurrences of the negative functionability events has been analysed and illustrated with several “real life examples”.*

## **Physical Reality of Mirce-mechanics- Part 3: Human World**

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### Abstract

*This paper provides an introduction to the Mirce-mechanics, a new discipline that studies the in-service behaviour of in-service life of maintainable systems in order to develop methods for the prediction of their functionability performance. The in-service life is viewed as a sequence of occurrences of functionability events that are taking place in the time domain. The main argument provided here is that successful prediction can be achieved only by understanding the mechanisms that drive physical processes, which generate the occurrence of functionability events. In this paper the mechanisms that cause the occurrences of negative functionability events that originate from the human world, has been addressed and analysed. Also, the human world that is inevitable part of the maintainable systems has been briefly analysed in order to familiarise the members of their design teams with their particular characteristics that are very different from the technical world familiar to mechanical, electrical, aeronautical and other types of engineers. Also, the impact of human actions on the occurrences of the negative functionability events has been analysed and illustrated with several "real life examples".*

**The Job of RMS Community is Provisioning  
of Work by Maintainable Systems<sup>5</sup>**

Dr Jezdimir Knezevic  
MIRCE Academy, Exeter, UK

*“Airlines are in the transportation business; Boeing, Douglas, Lockheed, Airbus, they're in the airplane business. You can have the shiniest looking airplane in the world, the most remarkably engineered airplane in the world, it's an academic marvel, it's an engineering marvel, but if the damned thing is not at B3 in Chicago at 9.15 to originate the trip to Cleveland, forget it.”*

Jack Hessburg (1934-2013) Grand Fellow of the MIRCE Academy,

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<sup>5 5</sup> This paper is dedicated to the life of Sarah Palmer-Tompkins (23.12.1971-8.2.2017) a person whom I never met but whose the most genuine, sincere and cheeky attitudes towards life constantly generated a unique smile in me, during her well covered public appearances.

## **Mirce- mechanics Approach to the Analysis of the Cosmic Radiation Impact on Aviation Reliability**

Dr J. Knezevic  
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### Abstract

*The main objective of this paper is to demonstrate the necessity of addressing all physical causes that lead to the transition of maintainable systems from positive to negative functionality state during their lives. Addressing the reliability characteristics of components and systems in isolation from the analysis of the impact of the natural environment on it, is not sufficient. Hence, results of the research performed in accordance to the Mirce-mechanics principles, have shown the significant impact of cosmic radiation on the in-service behaviour of aviation systems. Due to the rapid advances in electronics technology and the unrelenting demand for increased avionics functionality the complexity of avionics systems has risen exponentially. Hence, ever more advanced microprocessor and memory semiconductor devices are being used that exhibit an increased susceptibility to cosmic radiation phenomena. Single Event Effects have been the primary radiation concern for avionics since the late 1980's when the phenomenon, which had previously only been observed in orbiting satellites, also began to appear in aircraft electronic systems. The trend with each new generation of avionics system is to use increasing quantities of semiconductor memories and other complex devices that are susceptible to decreases in reliability due to ionising radiation from the cosmic rays from space. and alpha particles from radioactive impurities in the device itself. The interaction of this radiation can result in either a transient 'soft error' effect such as a bit flip in memory or a voltage transient in logic, alternatively a 'hard error' can be induced resulting in permanent damage such as the burn out of a transistor. Thus, this paper concludes that Mirce-mechanics approach to reliability is the only way forward for all members of the reliability community who wish to develop a method for accurate predictions of reliability, cost and effectiveness of aviation systems at early design stages, rather than to measure their in-service values and produce end of life statistics.*

## New Book: MIRCE Science by Jezdimir Knezevic

Jezdimir Knezevic



The Origin of MIRCE Science

This book is about the journey over the road that the author has travelled since birth till today, but it is not a book about him; it is a book about the quest for the new body of knowledge that he named MIRCE Science, the theory for predicting functionability performance of functionable system types. This long and demanding journey consisted of three paths:

- The first started with his childhood obsession with cars and autosport, progressing to building one by hand, using parts obtained from scrap yards, in a neighbour's garden. Two years later driving that car he earned one point in the National Rally Championship, while experiencing the physical phenomena of operation, maintenance and support processes (Part 1 of the book).

- The second took the author to

universities, libraries, institutes, companies and other organisations worldwide, in the quest for the scientific understanding of the mechanisms that lead to the occurrence of functionability events, resulting from physical, environmental and human actions. (Part 2 of the book).

- The third culminated in the creation of MIRCE: Functionability, Operability, Maintainability, Supportability and Profitability Equations, the mathematical derivation of which has been fully described in this book, based on MIRCE: Functionability Field and Space. (Part 3 of the book).

MIRCE Science comprises axioms, laws, mathematical equations and calculation methods that enable quantitative predictions of the impact of the physical world and in-service rules on the functionability performance of each feasible option of the future functionable system type to be made. The complexity of this undertaking, according to Jack Hessburg (1934-2013), the World's first Chief Mechanic (Boeing 777), requires the intellectual effort equal to winning a Nobel Prize!

Format: A4, Size: 232 pages

Media: Hard copy, hardback

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## **2018 Annals of MIRCE Science**

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- Presentations of the research results related to all aspects of MIRCE Science
- Applications of existing MIRCE Science knowledge
- Observational knowledge that could be beneficial for further developments of MIRCE Science
- Reports, book reviews and short news that are of a general benefit to MIRCE Science

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