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2013 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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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 transportation, communication, navigation and many others have been satisfied by human created machines like, trains, aircraft, cars, computers, telephones, radars, radios satellites and so forth. The mechanics of the functioning of machines 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.

Machines 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 machine 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 failures (inability of a system to satisfy felt needs.). To maintain functionality of a machine, actions like servicing, repairs, inspections, replacements and similar, are undertaken by humans. Thus, from the point of view of the ability to function during the in-service life, known as f**unctionability**[1]**,** a machine could be in a functionable or failed state, at any instant of time.

Experience teaches us that unlike quantitative information regarding the design-in functionality performance of a machine 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 machine in-service processes, which are characterised by uncertainty, discontinuity, irreversibility, inseparability, and dependence of time, location and humans.

To scientifically understand the mechanics of the motion of a machine through functionability states during in-service life and to develop laws and rules that enable predictions of emerging functionability trajectory to be made, at the decision-making stages, Dr Knezevic established the MIRCE Akademy at Woodbury Park, in 1999. Staff, Fellows, Members and students of the Akademy study in-service behaviours of a machine to:

- Determine the patterns of the motion of a machine through functionability states and to measure emerging functionability properties.
- Understand mechanisms of the motion of a machine through functionability states, within the physical scale from 10^{-10} to 10^{10} metre,
- Define the scheme for the prediction of emerging functionability measures for a given: machine 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 others 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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On The Non-Existence of Parallel Universes in Science[2]

Richard F. W. Bader, Grand Fellow of the MIRCE Akademy
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Abstract:

Thoughts on the divide that exists in science between those who seek their understanding within a universe wherein the laws of physics apply and those who prefer alternative universes wherein they are suspended or 'bent' to suit preconceived ideas. These dichotomies of views were bought to the fore with the development of the quantum theory of atoms in molecules (QTAIM). Those who deny the possible existence of a physical basis for the concepts of chemistry are placed directly at odds with QTAIM, whose very existence stems from the discovery that in the observable topology of the electron density, one finds the definitions of atoms, of the bonding between atoms and hence of molecular structure, the conceptual basis of chemistry. By relating these concepts to the electron density, a physically measurable property (that is, the expectation value of a Dirac observable), the theory provides the necessary link for their ultimate quantum definition, one that follows from the extension of a fundamental statement of physics to an atom in a molecule.[2] Feynman[3] and Schwinger[4] demonstrated how the classical action principle embodied in the Lagrangian approach to physics could be generalized to obtain its quantum analogue, an approach suggested by Dirac in 1933.[5] This suggestion led to Feynman's path integral formulation and to Schwinger's principle of stationary action. Schwinger's reformulation of physics, which is a differential statement of Feynman's path integral, combines the principle of least action with Heisenberg's equation of motion for the quantum observables, thus providing "all of physics" in a single statement.

[2] Professor Bader has submitted this paper to the MIRCE Akademy in June 2011 instead of the Grand Fellowship Award acceptance speech, as it was not possible for him to travel to the UK to deliver it, due to medical condition.

The Two Faces of Chemistry: Can they be reconciled?

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Abstract:

Shortly before his death, Richard Bader commented on the dichotomy that exists within chemistry and between chemists (Bader 2011). We believe that the dichotomy results from different goals and objectives inherent in the chemical disciplines. At one extreme are designers who synthesize new molecules with interesting properties. For these chemists, the rationale underpinning molecular synthesis is far less important than the end product—the molecules themselves. At the other extreme are the chemists who seek a fundamental understanding of molecular properties. We suggest tat the Quantum Theory of Atoms in Molecules, by virtue of the rich hierarchical structure inherent in the theory, offers a bridge through which to unite these two groups. However, if there is to be reconciliation, it falls to the theorists to develop "quantum mechanically" correct tools and concepts useful to the synthetic and applied chemist.

Atoms and Molecules in Mirce-mechanics Approach to Functionability

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

Abstract

Although functionability properties of machines are defined through probability characteristics, like reliability, availability and similar, the full understanding of them is only possible by observing, analysing and understanding of the physical mechanisms that generate negative functionability events. As the scientific understanding of the mechanisms that generate functionability phenomena, in Mirce-mechanics, is based on the fundamental understandings of the physical properties of atoms and molecules. The understanding and prediction of the properties of matter at the atomic level represents one of the great achievements of twentieth-century science. As matter is composed of atoms, this paper starts with its property and the manner in which the atomic elements are arranged. Electron density describes the distribution of the electronic charge throughout real space resulting from the attractive forces generated by nuclei. It is a measurable property that determines the appearance and form of matter. The theory developed to describe the behaviour of electrons, atoms and molecules differs radically from known Newtonian physics, which governs the motions of macroscopic bodies and the physical events of our everyday experiences. That new theory, which is able to account for all observable behaviour of matter, was named quantum mechanics. Thus, this paper presents the quantum theory approach to atoms in molecules, QTAIM, which is based on the revolutionary approached pioneered by Professor Richard F.W Bader (1931-2012)

Physics-of-Failure based Reliability Engineering

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Abstract

With increased use, complexity, and miniaturization of electronics in various applications, there is a need to improve the reliability of electronic products swiftly and cost-effectively. The shift from the use of traditional constant failure rate approaches to estimate the reliability of electronic products was enabled by physics-of-failure based reliability approaches. In a physics-of-failure based reliability assessment, the failure mechanisms that degrade products and ultimately produce failures are identified, based on the hardware configuration and anticipated life-cycle profile. Physics-of-failure models associated with specific failure mechanisms are utilized to provide a statistical distribution of the time-to-failure for a particular failure mechanism and site. Physics-of-failure based reliability assessment is integrated into the product development process to aid in design-for-reliability, stress test selection, product qualification, product screening, and prognostics and health management. This paper describes various steps involved in the physics-of-failure based reliability of electronic products and its integration into the product development process.

Mirce-mechanics Analysis of the Impact of Cosmic Phenomena on In-service Reliability

Ian. Zaczyk, Master of Mirce-mechanics
MIRCE Akademy, Exeter, EX5 1JJ, UK

Abstract

The main objective of this paper is to argue that the scientific approach to functionability is the only way forward for the engineering community if accurate predictions regarding occurrences of negative functionability events are to be made, which are to be confirmed during the operational processes of the future man made, managed and maintained systems. Hence, science based understanding of the mechanisms that cause occurrences of functionability events generated by the surrounding natural environment are required. Then and only then, accurate and meaningful functionability predictions become possible, which will ultimately lead to the reduction of the probability of the occurrence of failure events during the life of man made, managed and maintained systems. This paper focuses on the scientific understandings of the relevant cosmic phenomena on the in-service reliability of systems, as conducted within Mirce-mechanics principles.

Managing Machine Functionability
Using Methods of Complexity Science

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Executive Chairman, Multi-Agent Technology Group, London, UK

Abstract

The implication of Mirce-mechanics is that functionability trajectory patterns, driven by failure and repair events, are complex and therefore must be managed using methods of Complexity Science. Traditional methods for reliability and availability assessment and for planning and scheduling of in-service activities, spare parts supply and logistics are inadequate, as shown in [4], [5]. The new approach described in this paper, has been developed taking into account uniqueness of individual machine failure and repair patterns, component failure interdependencies and dependence of failure and repair patterns on changing operating and in-service conditions. To facilitate understanding of principles of the new approach an outline of the concept of Complexity is provided and references given to key developments in Complexity Science. In order to follow the author's arguments the readers will have to adjust their mindsets so that they can clearly distinguish between problems that can be solved using classical, Newtonian science and those that require a completely new approach – the Complexity Thinking.

Human Effectiveness of Troubleshooting Process in Commercial Aviation

John G. Hessburg, Jezdimir Knezevic,
MIRCE Akademy, Exeter, UK

Abstract

As with anything involving human factors, everybody has good days and bad ones from the point of view of troubleshooting. Additionally, the short turnaround times during the operating day do not allow for in-depth analysis before taking action to resolve an elusive system problem. It gets down to a business decision whether to delay this and successive flights in order to go through detailed troubleshooting (which will probably be unsuccessful anyway), or take a chance of incurring an NFF charge by replacing the most likely part. In almost every case, it is more cost-effective to pay the NFF. Then there are those systems with "built-in-test" assistance, which is often erroneous and/or misleading. The needle of truth may be buried in a haystack of other messages. These factors also add to the NFF rate. The main causes of imperfect troubleshooting are addressed in this paper, based on, over 40 years, of the author's experience in commercial aviation.

No Fault Found and Air Safety

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Cranfield University, Bedford, UK.

Abstract

*There is a view that has been expressed in some organizations that No Fault Found, NFF, is not an air safety issue. Consequently the occurrence of NFF and the rates for a particular fleet do not get the attention that they deserve in these organisations. In this paper it is shown that there is a distinct similarity between maintenance errors that could cause accidents and NFF causes and their impact on air safety. It is concluded that NFF needs a higher profile and the acknowledgement that it certainly **is** an air safety issue.*

Maintenance Axiom of Mirce-mechanics

Dr Jezdimir Knezevic
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Abstract

Reliability of maintenance process is quantifiable in statistical terms related to the occurrences of maintenance faults and errors. However as statistics does not study the causes of statistical behaviour, full understanding of the reliability of maintenance is only possible by understanding physical causes and mechanisms that lead to the occurrence of maintenance faults during th maintenance process. Based on the analysis of tens of thousands of maintenance tasks in defence, aerospace, transportation (including Formula 1 Grand Prix racing), communication and other industries the author has formulated the Maintenance Axiom of Mirce-mechanics, which is: The probability of faulty execution of any maintenance task is greater then zero. This axiom has a profound impact on all aspects of the life on any maintainable system, such as: reliability, availability, safety, cost, effectiveness and many others, on one hand, and associated processes like: manufacturing, operation, logistics support, on the other.

Planning In-service Support

John Crocker
Science Fellow of the MIRCE Akademy, Exeter, UK

Abstract

A major part of the cost of operating a fleet of high-valued, repairable assets (HVRA) is in keeping them operational. HVRAs generally only produce a return on investment when they are in use, performing the task[s] for which they were designed. Commercial aircraft, for example, usually earn revenue by carrying freight (passengers are often referred to as "self-loading" freight). Few aircraft generate income by sitting on tarmac, at least, not until they become museum exhibits. Maintaining these assets in a state of functioning can often cost the operators considerably more than the initial purchase price. Having the right spares in the right place at the right time is obviously important but significant savings can also be made by performing the right maintenance at the right time provided, of course, that it in no way compromises safety or any other legal requirements.

The Role of Simplified Technical English in Aviation Maintenance

Orlando Chiarello, Secondo Mona S.p.A., Italy

Abstract

The role that Simplified Technical English, STE, plays in aviation maintenance has been investigated and discussed in this paper. A brief history of the development of the ASD-STE100 specification [1] within the aviation industry, together with its range of application, an overview of its principles, structure and rules are presented. The primary objective of STE is the removal of linguistic barriers in the continuous attempt for correct understanding of the instructions by the operators, the improvement of flight safety and reliability.