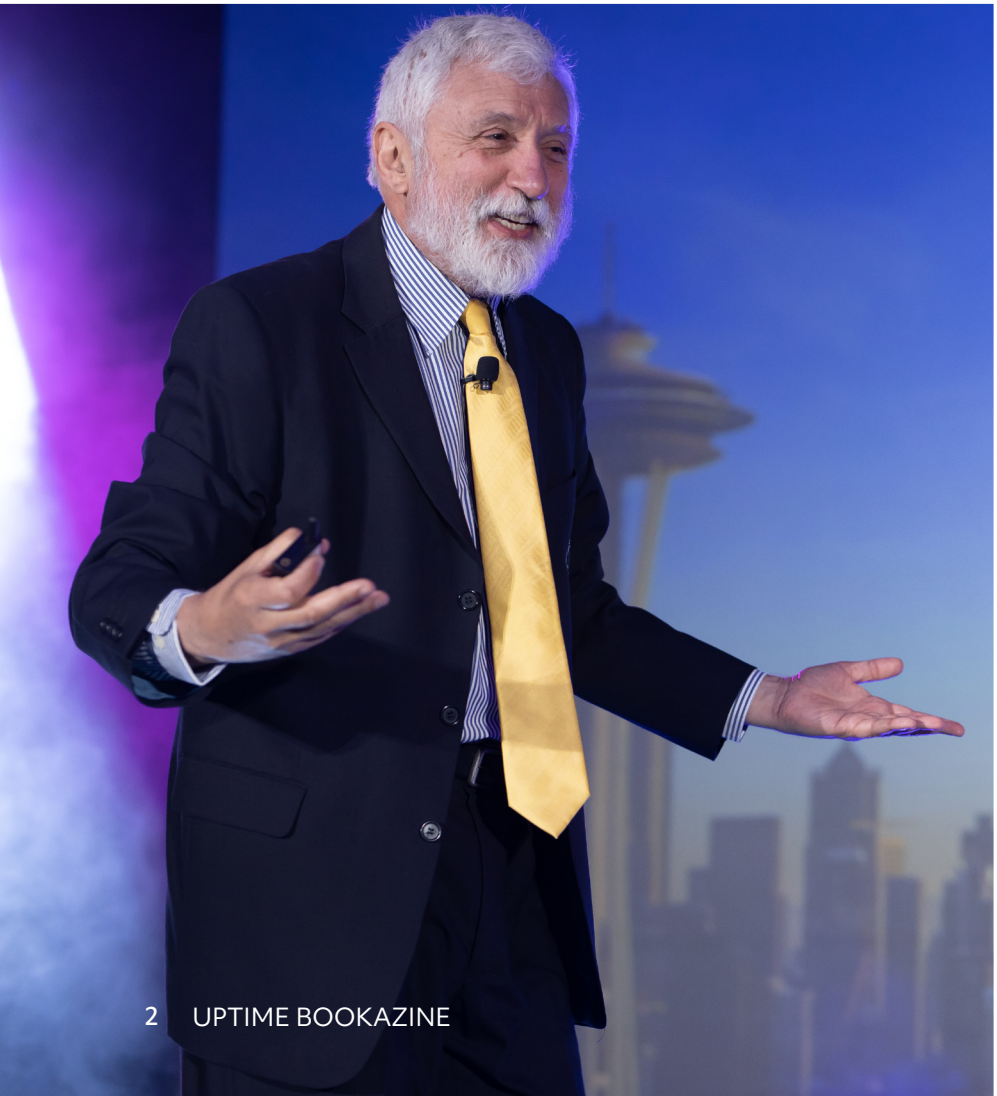

LAND ROVER


NOLAN


KRATKA ZAVORNA POT
IMT - 533 De luxe
YU



PROFESSOR JEZDIMIR KNEZEVIC

Q. You had a childhood obsession with cars and autosport, progressing to building one by hand and eventually racing that car. How did your car racing get you started on your study of reliability?

A. The objective of racing is to be first, but to be first, first you have to finish. So, not finishing was caused by failures of the car, some of which could have been rectified with allowed 30 minute delays, which means you had to have adequate spare parts, tools and equipment to do the repair. Hence, during the two years of rallying, I was looking for the answer to the question, "At the beginning of each rally, should I take a new water, oil, or petrol pump as a spare or get all three secondhand? As I could not find any body of knowledge to help me with the answer, I decided to study reliability, which seemed the best subject available.

Q. Did you think you would be drawn into engineering and maintenance?

A. Well, I expected that studies of reliability would cover maintenance, but they did not. So, after obtaining a Master's Degree in Reliability Engineering and completing my PhD studies in Maintenance Engineering – which from the theoretical point of view are very different from reliability – I became a mechanical engineer with postgraduate degrees in reliability and maintenance, but still actively seeking the answers to my "crossing the finish line" questions. That journey brought me to many universities and scientific organizations worldwide, each of which gave a part of the answer, but I was still looking for a coherent and comprehensive body of knowledge that would address my rallying concerns.

Q. When you established the Centre for Management of Industrial Reliability, Cost and Effectiveness (MIRCE) at Exeter University, UK, what did you envision it would become?

A. My main aim was to create an academic environment that would focus on building a scientific bridge between reliability and maintenance, which, in my view, are essential for the cost-effective operation of industrial systems. Through MIRCE, I started teaching reliability and maintenance courses to undergraduate students of engineering science (e.g., mechanical, electrical, civil and chemical), which was the first in the UK. Within the Centre, we have an Industrial Club, consisting of around 2,500 members, like design engineers, maintainers, logisticians, racing drivers, pilots, mathematicians, physicists, business managers, psychologists, meteorologists and many other professions that have an impact on "crossing the finish line" in my case of delivering business plans with private and governmental originations. I am proud to emphasize that the existence of the Centre was based exclusively on the earnings generated by our teaching, training and consulting activities, which means that during the 13 years of existence, we have not spent a single amount of taxpayers' money, which is not that common for university communities.

Q. Describe the various master's programs you have developed?

A. MIRCE offered the first European master's degree programs in reliability and maintainability engineering, logistics engineering, and system operational effectiveness. These courses were designed for people from industry with a minimum of five years of experience who needed to introduce operational reality into their office full of mechanical, electrical, civil and aeronautical engineers with no in-service experience. These are exactly the type of people I would have become had I not had rallying and racing experience. These part-time degree programs were supported by the global giants, like British Aerospace, Lockheed, Rolls-Royce, Siemens, Dowty Shorts, Bombardier, Westland Helicopters, the Royal Air Force, the South African Navy, the NATO Maintenance and Supply Agency (NAMSA), Martin-Baker, Lucas Aerospace, United Defense, GES Avionics, and many other companies worldwide. To deliver such complex programs, we had 23 professors from seven different departments within Exeter University and numerous guest lecturers from aerospace, defense, nuclear power and other industries worldwide.

Q. Describe in layman's terms what MIRCE Science is?

A. After 10 years of running postgraduate programs, over 200 students met Exeter University's requirements for a Master's degree. However, I realized that we still did not have a coherent body of knowledge to provide a scientific answer to my "crossing the finish line" reliability and maintenance questions. To fully focus on my scientific endeavor, I resigned from Exeter University in 1999, which closed the MIRCE as there was nobody to run it, and established the MIRCE Akademy at Woodbury Park, that time owned by Nigel Mansell, the 1992 Formula One and 1993 IndyCar World Champion. During the following 10 years, together with students, members and fellows of the Akademy, a new body of scientific knowledge was created that I named MIRCE Science. It provides quantitative answers to the questions I was posing during my rallying time 30 years ago through a system of equations, rules and methods that explain and predict measurable performance of future functionable systems, and minimizes occurrences of "nasty surprises," both physical and monetary, during their in-service lives at a time when the changes require minimum time, money and energy. The simplest example is: If for the same investment it is possible to double reliability or half maintenance, which option should be taken and why?

Q. Do you have an industrial example of the value add from applying MIRCE Science?

A. MIRCE Science has been the foundation of the creation of training and procedures activities during the establishment of the Airbus Operability Department. It was used during the designs of the A380 and A350 passenger aircraft through training courses run at Filton, UK; Toulouse, France; Bremen, Germany; and Madrid, Spain. Also, MIRCE Science was a foundation for getting and delivering various research projects, like these:

- Development of operability laws, Airbus, Toulouse, France;
- Review of Airbus A380 operational reliability prediction model and its results in relation to in-service data, Airbus, Toulouse, France;
- Development of enhanced failure data analysis techniques for improved aircraft reliability performance, Airbus, Toulouse, France;
- Identification of prediction and assessment technique for aircraft operability, Airbus, Toulouse, France;
- Human error analysis in maintenance, Airbus, Filton, UK.

The results of our research have been firmly embedded into Airbus and approved and used in processes and procedures and the equivalent documents for thousands of their suppliers worldwide.

Q. As a student of MIRCE, what opportunities are provided? Are there particular organizations where your students can apply what they have learned?

A. Our students are exposed to the new way of addressing and understanding in-service behavior of functionable systems. For example, currently used reliability block diagrams of an aircraft do not contain a single block related to air, which is essential for both functionality and functionability of it. So, our students are the new type of top decision makers who are able to foresee the future of in-service performance of the products and services at the time when the most significant decisions and trade-offs are made among competing options and the consequences that will be faced by users, operators, humans and the environment during several decades and centuries. Hence, our students are "responsible" for all reliability and maintenance design-in characteristics that unquestionably drive in-service performance, cost and the safety of nuclear submarines, space stations, spacecrafts, power stations, industrial plants, military systems, and the like. In fact, many of them do not even know yet that this type of expert even exists! Obvious candidates are SpaceX, NASA, Virgin Galactic, the European Space Agency (ESA) and similar organizations that are dealing with projects for which in-service data does not exist at all and yet the projects must proceed!

Q. During one of your presentations at The RELIABILITY Conference 2019, you mentioned the Monte Carlo simulation. This was a bit of a breakthrough for you. Can you elaborate why that was?

A. I conceived the mathematical system of equations required for the applications of MIRCE Science about 15 years ago, but their complexity was beyond the ability of mathematical methods to generate the numerical results. However, that was not only a problem of MIRCE Science, but all scientific disciplines that are based on an infinite sum of convolution integrals. Faced with that problem, developers of nuclear bombs at the Los Alamos National Laboratory in New Mexico developed an alternative method for solving those integrals under the code name "Monte Carlo." Hence, when I, educated as a deterministic mechanical engineer, learned about it from my dear colleague and friend, the late Professor Arie Dubi, a Grand Fellow of MIRCE Akademy, the door for the applications of MIRCE Science fully opened. By making use of the Monte Carlo simulation, it became possible to predict the expected functionability performance of systems, the complexity of which is governed by multi-dimensional relationships of thousands of consisting components that are exposed to aging processes, maintenance induced errors, environmental conditions during operation, transportation and storage, and complicated regulations and rules, all of which are properly defined and incorporated into MIRCE functionability, maintainability, supportability, operability and profitability equations.

Q. You have written three books. Who is your target audience? Do you need to be a mathematician to read and understand them?

A. The books that I authored or coauthored are addressed to practicing engineers, managers, students and researchers. As mathematics is the only human activity that enables predictions to be made by using a necessary equation, a working knowledge of mathematics is required, which is far from being a mathematician! MIRCE Science equations could be successfully incorporated into software, which drastically reduces demands for complex mathematical calculations. For that reason, the practical applications of the Monte Carlo simulations were only possible with a development of modern computers.

Q. What's next for you? Your work?

A. Great question! The theoretical part of MIRCE Science is completed, tested and verified. However, my greatest challenge for the future is twofold:

- First, continuous research toward the understanding of physical mechanisms that govern occurrences of functionability events within the scale of 10^{-10} of a meter (atomic scale) and 10^{+10} of a meter (solar system), which is necessary for the accuracy of the predictions;
- Second, finding the best media for transferring a half of century of my experience and passion for generating the body of knowledge for increasing probability of "crossing the finish line" with new generations of scientists, engineers, managers and, above all, technologists, who are needed for the development of the software that would enable easier applications of MIRCE functionability equations and "taming" the artificial intelligence community to focus also on the generation of the future data rather than to analyze the past one.

Q. You often mention the word functionability. What is the difference between functionality and functionability as far as MIRCE Science is concerned?

A. Thank you for paying attention to my statements. Functionally is related to inherent properties and performance of an asset, product, or service. For example, a functionality of a commercial aircraft is described through measures like speed, range, carrying capacity, fuel consumption, etc. However, the functionability performance of the same aircraft is related to its in-service punctuality, number of maintenance man-hours, crew commonality, logistics delay times, and similar measures experienced by operators and users. For example, the very first B747, flown by Pan Am, had been airborne 80,000 hours in revenue generating services, but it had been exposed to 806,000 maintenance man-hours, over 22 years of its life span. In summary, well established sciences like thermodynamics, material science, fluid mechanics, electrodynamics and similar deal with functionality performance, whereas MIRCE Science, to the best of my knowledge, is the only one that deals with functionability performance.