

# 25<sup>th</sup> MIRCE International Symposium

8 – 9 December 2015, Woodbury Park, Exeter, UK

## In-service Reliability

- *Prognostics and Troubleshooting as Mechanisms of Motion in Mirce Mechanics* -



Photo by Jeff Pike

“It is readily accepted that a **“bottom line takes organisation forward”**, but it is not well understood that a main task of maintaining operational effectiveness is not “repair” of system’s failures, but their management in the manner that maximises operational effectiveness, quantified through: profit, customers’ satisfaction, loyalty, reliability, punctuality and other desirable properties of maintainable systems.

To create and manage operationally effective systems a full understanding of the mechanisms of **Mirce Mechanics** is necessary as they drive systems through positive and negative functionability states. These mechanisms are of a complex nature as they result from strong interactions between physical properties of a system, in-service environmental conditions and associated human actions.

Hence, you are warmly invited to join us and learn more about methods, principles and tools that we developed to elevate the bottom line to the level at which everybody is happy, producers, users, managers, investors, legislators, insurers, general public and the life supporting natural environment. “

Dr J. Knezevic, Founder & President of the MIRCE Akademy

*\* Mirce Mechanics is a scientific theory for delivering functionability requirements to maintainable systems through failure management.*

# The Symposium Programme at Glance

>>>>> **Tuesday 8<sup>th</sup> December 2015** <<<<<

0830-0900	<b>Registration and welcome coffee, Woodbury Park Hotel,</b>	
0900-1030	<i>Troubleshooting as a Mechanism of the Motion in Mirce Mechanics</i> Dr Jezdimir Knezevic, Founder & President, Mirce Akademy, UK	
1030-1100	<b>Morning Coffee</b>	
1100-1200	<i>Troubleshooting as a Mechanism of the Motion in Mirce Mechanics (continue0</i>	
1300-1400	<b>Lunch Break</b>	
1400-1530	<i>Troubleshooting as a Mechanism of the Motion in Mirce Mechanics (continue0</i>	
1530-1600	<b>Afternoon Tea</b>	
1600-1730	<i>Troubleshooting as a Mechanism of the Motion in Mirce Mechanics (continue0</i>	
18.00-19.00		<b>MIRCE Akademy Annual Lecture</b> <b>Successful Fault Resolution in the RAF</b> Wg Cdr CJ Hockley OBE CEng MRAeS RAF (Rtd), EPSRC Centre for Through-Life Engineering Services (TES), Cranfield University, UK and Honorary Fellow of the MIRCE Akademy
1910-1930	<b>Get Together Sherry Reception</b> <b>at Woodbury Park Golf Hotel</b>	
1930-2230		<b>Symposium Dinner &amp; MIRCE Akademy Members Christmas Dinner</b> Formula 1 Reliability & Effectiveness Centre, of the MIRCE Akademy <b>Announcement and Award of</b> <ul style="list-style-type: none"> <li>• 2015 Formula 1 Driver Reliability Champion</li> <li>• 2015 Formula 1 Team Reliability Champion</li> </ul> In accordance to the Mirce Mechanics based analysis

>>>>> **Wednesday 9<sup>th</sup> December 2015** <<<<<

0830-0900	<b>Registration and welcome coffee, Woodbury Park Hotel,</b>	
0900-1030	<i>Prognostics as a Mechanism of the Motion in Mirce Mechanics</i> Chris Burden, Applied engineering Prognostics Science - AePS, UK	
1030-1100	<b>Morning Coffee</b>	
1100-13.00	<i>Prognostics as a Mechanism of the Motion in Mirce Mechanics (continue)</i>	
1300-1400	<b>Lunch Break</b>	
1400-1530	<i>Prognostics as a Mechanism of the Motion in Mirce Mechanics (continue)</i>	
1530-1600	<b>Afternoon Tea</b>	
1600-1700	<i>Prognostics as a Mechanism of the Motion in Mirce Mechanics (continue)</i>	

***“Mirce mechanics delivers flights on time by managing failures, while Aircraft mechanics fix broken flying machines.”***

Dr J. Knezevic in the “spirit” of Jack Hessburg GFMA (1934-2013)

## Troubleshooting as a Mechanism of Motion in Mirce Mechanics

Every maintenance organization is responsible for performing the full range of maintenance tasks. However, not all tasks count equally in determining whether or not an organization is doing a good job. The basis for judging the efficiency and effectiveness of a maintenance organisation, and of individual maintenance workers, is the ability to find and fix problems efficiently. For example, in today's competitive air carrier business environment, maintenance organisations are judged on their ability to keep aircraft safely in the air -- not how good they are on the ramp or in the hangar.

Maintainers must possess both the knowledge and skills to find and fix problems efficiently. These requirements are essentially no different than those for medical doctors and any other profession or craft that involves both diagnostic and manual skills. As one might expect, the most valued maintenance abilities are also the most difficult to acquire and practice. Many years of research, on-the-job observations, and common experience have demonstrated that it is much easier to teach and learn manual skills than troubleshooting skills.

In this presentation, some fundamental human factors concepts related to testing and troubleshooting are discussed and demonstrated through real life examples. Some of the findings may appear counter to experience. Testing and troubleshooting are complex topics as it is driven by both sides of equation, namely system manufactures that conceive troubleshooting issues and maintenance managers that deal with them.

- Most maintenance managers and supervisors probably have neither the desire nor the abilities to develop and implement a diagnostic training program
- Maintenance supervisors have almost total control over the selection and use of stand-alone test equipment. On the other hand, maintenance organizations have very little control over aircraft manufacturers' design of automated troubleshooting systems
- While it is difficult to teach troubleshooting skills, it is certainly possible.

The goal of every maintenance organization is 100% error-free performance. While this is a worthwhile goal, it is against the axioms of Mirce Mechanics that states the probability of human error in the execution of any task is greater than zero. As most of diagnostics activities including testing and troubleshooting include a human element, the only realistic goal is to *reduce the probability of* troubleshooting errors as much as possible.

Common error-reduction methods will be discussed, include the following:

- Automate the process
- Instruct in algorithms or heuristics
- Proceduralise (step by step guidance)
- Practice (hands-on)
- Reduce Complexity
- Relax time pressure
- Individual selection of maintainers
- Work in teams.

**Dr K's comment:** *As it is true of all skills, troubleshooting proficiency cannot be attained simply by reading books or by listening to someone explain what to do or watching a video.*

## **Prognostics as a Mechanism of the motion in Mirce Mechanics**

All operational devices have a 'birth and death', which follows a path of a creation, operation, decay and 'broken' state. The journey along this path is the 'life' of the device for which there are many instances of 'good' and 'bad' functionality. Some are passive, simple and supported by remedial action others result in failures that are best 'phew' that was close and others are 'oh dear', fatalities. These defined 'life' routes of an operational device live in a risk culture of design, operational intent, functionality, maintainability, serviceability and most important of all, identification of the 'change' events. These 'change events' or deviations from 'normal' operation are the catalyst for first call increased observation, generation of the probability route of decay and the selection, identified by the decay set against the FMECA, of the 'stepping stones' to capture the failure mode emulating before disaster.

The integrity of the device for all these scenarios resides in the risk management activity of 'watching for change' and this is the weakness in the current business culture. Operators of devices can currently mitigate failures against subjective ignorance of events, compliance to maintenance requirements and insurance cover bolsters. Whilst all this is the current flavour of business for the devices, because it is very finance centric, engineering 'pull' for improved prognostics stalls. However, make the prognostic capability a valued insurance assessor that can reduce risk and the playing field starts to change. To explain the variance in operational mechanisms that transport people, example from 3 films will be used.

The 'current' method, film **Rush** where prognostic 'feelings' for conventional cars – based on the car – produces many accidents, some of which are fatal, each year, but the cause of the accident is usually attributed to human error (95% as an estimate value). To address this, vehicle manufactures are introducing capabilities like automatic braking to compliment the now common proximity sensors used for reversing. These capabilities are evolutionary to prevent fatalities, but not to necessarily address car speeds, but to assist in over populated roads and drivers whose attention gets distracted. These new features are also the 'quirks' of the industry to entice drivers to make new purchases of capable vehicles and push a market of sales improvement. However, vehicle road space is becoming a premium as city roads become saturated and the issues of pollution manifest, resulting in cultural habit changes of how and where to go to work. Soon multi-lane elevated road systems will try to pervade, but planners and bureaucratic peers with vested interests will block this change and the on and off access to the system will bottle neck. So we need to change the road system or augment better control of vehicles.

Bring in the mag-lev type of transport vehicle; watch the film '**Total Recall**' for a vision of a Multi-tier magnetic track system resulting in vehicles with no wheels, no tyres and on an elevated track system. These vehicles now need a 'better' sense of awareness capability to prevent accidents, and a comprehensive self- intuitive system for the detection of system functional failure that can prognose 'deviation' from 'normal/correct' operation. However the prognostics of the 'dynamic' system malfunction have elevated as the transport vehicle operates at 'altitude' and won't just stop on the road.

Move onto the '**Star Wars**' scenario and the game changes again but this time no mag-lev roads just 'free-air'. Now we need a surety of the vehicle operation as any failure could be a 'fall out of the sky' situation. Funny enough you are back at the modern air liner, a multi-people carrier, off the ground floating at speed through turbulent air at the whim of its power systems, operating as intended but as with all machinery in a calculated state of 'decay'.

**Chris's comment:** *Understand that decay better with a prognostic attitude, mitigated with reduced fatal collateral and the human race is moving forward into the future!*



**Exeter** is the most southwesterly Roman fortified settlement in Britain. Exeter Cathedral was founded in the early 12th century and has several notable features, including an early set of misericord, an astronomical clock and the longest uninterrupted vaulted ceiling in England. Today, Exeter is identified as one of the top ten most profitable locations for a business to be based or to gain University education.

All prices are in GB Pounds	Before 1st November 2015			After 1st November 2015		
	Price	VAT	Total	Price	VAT	Total
Participant for 2 Days	395.00	79.00	<b>474.00</b>	445.00	89.00	<b>534.00</b>
Participant per Day	215.00	43.00	<b>258.00</b>	250.00	50.00	<b>300.00</b>
Presenter on the day	Free			Free		
Presenter for 2 Days	295.00	59.00	<b>354.00</b>	325.00	65.00	<b>390.00</b>
Retired participants for 2 Days	175.00	35.00	<b>210.00</b>	195.00	39.00	<b>234.00</b>
University students for 2 Days	325.00	65.00	<b>390.00</b>	375.00	75.00	<b>450.00</b>
Congress Proceedings on CD	150.00	30.00	<b>180.00</b>	175.00	35.00	<b>210.00</b>
MIRCE Akademy Members	350.00	70.00	<b>420.00</b>	495.00	99.00	<b>594.00</b>
MIRCE Akademy Fellows	375.00	75.00	<b>450.00</b>	505.00	101.00	<b>606.00</b>
MIRCE Akademy Students	275.00	55.00	<b>330.00</b>	295.00	59.00	<b>354.00</b>
Symposium Dinner only	50.00	10.00	<b>60.00</b>	50.00	10.00	<b>60.00</b>
<b>B&amp;B at Woodbury Park Hotel</b>						
Single			<b>75.00</b>			<b>75.00</b>
Double			<b>95.00</b>			<b>95.00</b>



## About the Venue

Woodbury Park is a magnificent 500 acre complex set among rolling hills above the South West English coastline, only a few miles from Exeter.

Communication between Exeter and other parts of the United Kingdom are excellent.

**By road**, the M5 motorway links Exeter to London, the Midlands, Scotland and Wales. Regular rapid coaches run services to and from London and Heathrow Airport.

**By rail**, a regular fast service is available to and from Exeter (St David's Station) and London (Paddington Station).

**By air**, Exeter Airport offers regular flights to many British and Continental destinations and is situated near to Woodbury Park.

Travel between Exeter and Woodbury normally requires a car or taxi.

**Among the outstanding leisure facilities at Woodbury Park are two golf courses including the magnificent Oaks Championship course, tennis courts, a swimming pool, spa, sauna and fully equipped gymnasium and well appointed lounge areas and bars.**

Woodbury Park, Woodbury, Exeter, EX5 1JJ, United Kingdom

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🌐 [www.woodburypark.co.uk](http://www.woodburypark.co.uk)

## About the MIRCE Akademy

Mirce Akademy is an independent research and educational institution devoted to the enhancement and applications of Mirce Mechanics – scientific theory of the motion of functionality through the life of maintainable systems.

The knowledge and methods of Mirce Mechanics have benefited designers, manufacturers, constructors, operators, service-providers, regulators and others in the aerospace, automotive, communication, construction, defence, transport, service, utility sectors and other areas of business and government.

Benefits of scientific based knowledge are experienced through significant increase in system reliability and availability, while drastically reducing costs of making, running and disposing systems.



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Woodbury Park Hotel & Golf Club, Exeter, EX5 1JJ, UK – home of the MIRCE Akademy

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## In-service Reliability: 8 – 9 December 2015

### Registration Form

Email: [quest@mirceakademy.com](mailto:quest@mirceakademy.com)

Phone: +44 (0) 1395 233 856

Mail: MIRCE Akademy, Woodbury Park, Exeter, EX5 1JJ, United Kingdom

Web site: [www.mirceakademy.com](http://www.mirceakademy.com)

THIS FORM MAY BE COPIED

Please select appropriate level of service and corresponding fee.

Group discounts are available please contact us.

### The Symposium Fees includes:

- Attendance
- Symposium Material and Supporting Materials
- Lunches and Light Refreshments
- MIRCE Akademy Annual Lecture
- Christmas Dinner on 8<sup>th</sup> December
- Visit to Auto Racing Championship Centre

### Value Added Tax (VAT)

Unless special exemption exists, under UK Customs and Excise regulations delegates from all countries are required to pay UK VAT @ 20 % on all courses taking place in the UK. Non-UK delegates may be able to recover VAT incurred via the relevant tax authority in the country of origin of the delegate.

### PAYMENT DETAILS

Please invoice my organisation (**Note: UK MOD personnel can pay by BACS through the DBA – Contractor Number will be supplied with invoice**)

For the attention of \_\_\_\_\_

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Please Charge credit card £ \_\_\_\_\_

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### PERSONAL DETAILS (Please print clearly)

Surname \_\_\_\_\_

First name \_\_\_\_\_

Organisation \_\_\_\_\_

Department \_\_\_\_\_

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Postcode \_\_\_\_\_ Country \_\_\_\_\_

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Special requirements                      Yes                      No

Please specify  
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I understand and accept the registration terms and conditions as shown

Signature \_\_\_\_\_ Date \_\_\_\_\_

### Terms and Conditions

Substitution of participants may be made at any time. If you intend to do this, please advise the MIRCE Science ('the organiser') as soon as possible. Cancellation of a booking must be received in writing by the organiser at least 14 days before the commencement of the Symposium. MIRCE Science regrets that no refunds or credits will be made after the deadline unless the organiser cancels the Event.

The organiser reserves the right to alter the programme or cancel the Summer School at its discretion. All places offered are subject to availability.