International Specialised Skills Institute

CELEBRATING 25 YEARS

PASSIONATE PEOPLE. GREAT IDEAS.
A BETTER SKILLED AUSTRALIA.

Automotive Vehicle Powertrains and E-Mobility – THE FUTURE

Ron Locandro

2014 Italian Services Institute of Australia

An ISS Institute Fellowship sponsored by

Italian Services Institute of Australia

Italian Services Institute

International
Specialised
Skills
Institute

ISS Institute
Level 1
189 Faraday Street
Carlton Vic
AUSTRALIA 3053

T 03 9347 4583
F 03 9348 1474
E info@issinstitute.org.au
W www.issinstitute.org.au

Published by International Specialised Skills Institute, Melbourne

Extract published on www.issinstitute.org.au

I. EXECUTIVE SUMMARY

The purpose of this ISS Institute Fellowship was to undertake applied research and gain industry knowledge on innovations and changes in the automotive technologies aspects of vehicle alternative fuel powertrains and E-mobility in Germany, Netherlands and the USA. Industry training methodologies and knowledge underpinning automotive vehicle powertrains and E-mobility was also researched and the aim will be to distribute the findings to the Australian Automotive training industry such as (TAFE), Government and other stakeholders.

The Fellow, Ron Locandro, aims to then make recommendations to all automotive industry stakeholders to assist and guide their decisions on vehicle powertrains and E-mobility technology training in Australia.

After travelling over 68,000 kilometres and undertaking a five week research tour of Germany, Netherlands and the USA, the Fellow identified the training required for service technicians to carry out servicing, repairs and diagnostic requirements for new innovations in vehicle alternative fuel powertrains and E–mobility devices. He also identified the learning resources required for facilitation of training and the learning strategies incorporated by training organisations in Germany, Netherlands and the USA, as well as the scope and availability of professional development for instructors.

The Fellow identified that the current availability of technical information, training and learning resources available to instructors and learners in Germany, Netherlands and the USA is far ahead of ours in Australia.

The importance of developing and maintaining a highly trained skilled workforce and the availability of teaching and learning resources and methodologies for facilitation of training is paramount in Australia. Germany, Netherlands and the USA recognised this importance and demonstrated more advanced to those in Australian TAFE delivery and aftermarket sector.

TABLE OF CONTENTS

II. ABBREVIATIONS/ACRONYMS

AAIW	Automotive Aftermarket Industry Week
AAPEX	Automotive Aftermarket Product Expo
AAFRB	Automotive Alternative Fuels Registration Board (Victoria)
AC	Alternating Current
AGM	Absorbed Glass Mat Battery
AQF	Australian Qualifications Framework
ASA	Auto Skills Australia Ltd
ATV	Automotive Training Victoria
BAS	Belt Alternator Starter
BEV	Battery Electric Vehicle
BMS	Battery Management System
CAT	Category rating
CNG	Compressed Natural Gas
CVT	Continuously Variable Transmission
DC	Direct Current
DTC	Diagnostic Trouble Code
ECU	Electronic Control Unit
ECVT	Electronic Continuously Variable Transmission
EV	Electric Vehicle
HEV	Hybrid-electric-vehicle
HSG	Hybrid Starter Generator
HV	High Voltage
IAME	Institute of Automotive Mechanical Engineers
ICE	Internal Combustion Engine
IMA	Integrated Motor Assist
ISAD	Integrated Starter Alternator with Damping
ITAB	Industry Training Advisory Board
IEC	International Electro technical Commission
LIB	Lithium-Ion Battery
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MESSE	Fair exhibition
MG1	Motor Generator 1

II. ABBREVIATIONS / ACRONYMS

MG2	Motor Generator 2
NATEF	National Automotive Technicians Education Foundation
NiMH	Nickel–metal hydride battery
NSSC	National Skills Standards Council
NTAN	National TAFE Automotive Network
OEM	Original Equipment Manufacturer
PHEVs	Plug-in hybrid electric vehicles
PPE	Personal protective equipment
RESS	Rechargeable energy storage system
SAE	Society of Automotive Engineers
SELV	Separated extra-low voltage
SEMA	Specialty Equipment Market Association
SOC	State of Charge
SMR	System Main Relay
SUV	Small Urban Vehicle
SWOT	Strengths, Weaknesses, Opportunities and Threats
VACC	Victorian Automotive Chamber of Commerce
VAF	Victorian Automotive Forum
VET	Vocational Education and Training
WHS	Workplace health and Safety

III. DEFINITIONS

Design: Design is the creation of a plan or convention for the construction of an object or a system.

Innovation: Creating and meeting new needs with new technical and design styles.

Hybrid: Hybrid-electric vehicles (HEVs) are alternative fuel vehicles. By pairing an electric motor with a petrol engine, hybrid cars provide benefits such as improved fuel economy, increased power.

Series Hybrid: A hybrid vehicle design in which there is no mechanical connection between the Internal Combustion Engine (ICE) and the drive wheels. The ICE drives a generator that produces electricity.

Parallel hybrid: A hybrid vehicle design in which the electric motor assists the ICE to propel the vehicle.

Series-Parallel Hybrid: A hybrid vehicle design that can operate as a series hybrid, a parallel hybrid, or both at the same time.

Regenerative braking: The electric motor found in some alternative fuel vehicles applies resistance to the drivetrain, causing the wheels to slow down. In return, the energy from the wheels turns the motor, which functions as a generator, converting energy normally wasted during coasting and braking into electricity. A battery stores this electricity until needed by the electric motor.

Electric motor drive/assist: The electric motor in hybrid cars boosts power to the engine during acceleration, passing cars, or climbing hills. It augments performance when needed and allows hybrid cars to run on smaller, more efficient engines. In some hybrid cars, the motor alone provides power for low-speed driving conditions where internal combustion engines are least efficient.

Automatic start/shutoff: In some hybrid cars, the engine shuts off automatically when the vehicle comes to a stop and restarts when the accelerator is pressed. This prevents wasted energy from idling.

Stop-start: Technology allows your engine to switch off when it is idling, reducing fuel consumption and emissions.

Biodiesel: Biodiesel is a form of diesel fuel manufactured from vegetable oils, animal fats, or recycled restaurant greases. It is safe, biodegradable, and produces less air pollutants than petroleum-based diesel.

Ethanol: Ethanol is an alcohol-based fuel made by fermenting and distilling starch crops, such as corn. It can also be made from 'cellulosic biomass' such as trees and grasses. The use of ethanol can reduce our dependence upon foreign oil and reduce greenhouse gas emissions.

Natural gas: Natural gas, a fossil fuel comprised mostly of ethane, is one of the cleanest burning alternative fuels. It can be used in the form of compressed natural gas (CNG) or liquefied natural gas (LNG) to fuel cars and trucks.

Liquefied petroleum gas (LPG): Propane or liquefied petroleum gas (LPG) is a clean-burning fossil fuel that can be used to power internal combustion engines. LPG-fuelled vehicles produce fewer toxic and smog-forming air pollutants.

III. DEFINITIONS

Electric: Electric vehicles (EVs) are propelled by an electric motor (or motors) powered by rechargeable battery packs.

Fuel cell: Fuel cell vehicles (FCVs) are an emerging technology and has the potential to significantly reduce energy use and harmful emissions, as well as our dependence on foreign oil.

Hydrogen: Hydrogen (H2) is being aggressively explored as a fuel for passenger vehicles. It can be used in fuel cells to power electric motors or burned in internal combustion engines (ICEs).

Powertrain: The group of components in a vehicle that generate power and deliver it to the road surface.

E-Mobility: Represents the concept of using electric powertrain technologies, in-vehicle information, and communication technologies and connected infrastructures to enable the electric propulsion of vehicles and fleets.

1. ACKNOWLEDGEMENTS

Ron Locandro of Chisholm Institute would like to personally thank the following individuals and organisations who gave kindly their time and their knowledge to recommend, support and direct him throughout the Fellowship program.

Awarding Body – International Specialised Skills Institute (ISS Institute), is an independent, national organisation that for over two decades has worked with Australian governments, industry and education institutions to enable individuals to gain enhanced skills and experience in traditional trades, professions and leading edge technologies.

At the heart of the ISS Institute are our Fellows. Under the Overseas Applied Research Fellowship Program the Fellows travel overseas. Upon their return, they are required to pass on what they have learnt by:

1. Preparing a detailed report for distribution to government departments, industry and educational institutions
2. Recommending improvements to accredited educational courses
3. Delivering training activities including workshops, conferences and forums.

Over 300 Australians have received Fellowships, across many industry sectors. In addition, recognised experts from overseas conduct training activities and events. To date, 25 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010':

> Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change.
>
> International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills, but also multiple and higher level skills and qualifications. Deepening skills across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills across a range of industries and occupations.

In this context, the ISS Institute works with Fellows, industry and government to identify specific skills in Australia that requires enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional practice, which they then share with their peers, industry and government upon their return. This is the focus of the ISS Institute's work.

1. ACKNOWLEDGEMENTS

Fellowship Sponsor: Italian Services Institute

The Italian Services Institute of Australia is a body created to advance the education of Australian residents who are of Italian descent and need the support of a Fellowship to enable them to enhance their skills and knowledge.

Supporters

- Mr Sauro Antonelli, General Manager, Italian Services Institute)
- Mr Craig Van Batenburg CEO Automotive Career Development Centre, Worcester, Massachusetts, USA
- Mr Daniel Brown Manager of the Lucas-Nuelle Academy (Kerpen Germany)
- Mr Anthony O'Mara Operations Manager, Automotive Alternative Fuels Registration Board (AAFRB Australia)
- Mr Neil Hunichen Auto Skills Australia Ltd (ASA)
- Mr Phil Austin Technical Training Manager BMW (Australia)
- Mrs Georgina Groves Account Manager CDX Automotive (AUS & NZ)
- Mr Clifford Worthley Department Head Worcester Technical High School, Worcester, Massachusetts, USA

Employer Support

Ron Locandro would like to acknowledge his employer, Chisholm Institute of TAFE, for the support given in the provision of access to the required resources to complete this Fellowship.

Specific acknowledgement must go to the support given by the following:

- Craig Brittle (Chisholm Institute) – Workplace Mentor
- Barry Jones (Chisholm Institute) - Report Writing Mentor
- Neil Hunichen Auto Skills Australia Ltd (ASA) - Report Writing Mentor
- Alan Platt (Ringwood Trade Training Facility) – Industry Mentor
- Anthony O'Mara (AAFRB Australia) – Industry Mentor
- Craig Van Batenburg Automotive Career Development Centre. Worcester, Massachusetts USA) – Industry Mentor.

1. ACKNOWLEDGEMENTS

Organisations Impacted by the Fellowship

- Institute of Automotive Mechanical Engineers (IAME)
- Auto Skills Australia Ltd (ASA)
- Victorian Automotive Forum (VAF)
- Victorian Automotive Chamber of Commerce (VACC)
- Automotive Alternative Fuels Registration Board (AAFRB Australia)
- Chisholm Institute and the TAFE (Technical and Further Education) sector
- VET Development Centre
- Australian Standards (AS)
- Circular reference group (CRG)

2. ABOUT THE FELLOW

Name: Ronald Ross Locandro

Employment: Automotive Instructor, Chisholm Institute

Qualifications:

- Certificate III in Automotive Studies, Dandenong Collage of TAFE (1986)
- VACC, Automotive Certificate of a Motor Mechanic (1989)
- Post Apprenticeship LPG Tuning & Maintenance, Box Hill TAFE (1989)
- AAFRB-LPG Accreditation (1993)
- VIC Roads Licensed RWC Tester, Box Hill TAFE (LV 1995) (TAXI 2003)
- Certificate IV in Assessment & Workplace Training BZ, Chisholm Institute (2002)
- Diploma of Vocational Education and Training VET, Chisholm Institute (2008)
- LNG/CNG Service & Repair, South West TAFE (2009)
- Certificate IV in Training and Assessment TAFE, Chisholm Institute (2011)
- Graduate Certificate in Vocational Education and Training VE, Chisholm Institute (2011)
- Hybrid and Electric vehicles BO0004, Bosch (2013)
- Cert II Air conditioning AUR20705B, Chisholm Institute (2013)
- Certificate IV in Training and Assessment, Chisholm Institute (TAE LLN) (2013).

Memberships:

- Institute of Automotive Mechanical Engineers (IAME)
- Victorian Automotive Forum (VAF) committee member.

Biography:

Ron Locandro worked as an adult apprentice motor mechanic for Courtney & Patterson (Ford) performing automotive servicing and repairs from 1984. This work activity continued until he completed his trade schooling in 1986 when he moved to a number of smaller workshops to extend his knowledge base in a wider range of different vehicles. Locandro then sat a VACC examination and achieved his trade recognition in 1989.

Locandro joined Cranbourne Gas Conversions in 1992 where he found his niche working with alternative fuels. The Fellow's employment for the next 15 years included workshop manager, lead technician, diagnostic work, LPG installation, administration duties, technical support to customers and trade enquiries.

Locandro commenced sessional teaching at Chisholm TAFE in 2000 until receiving a full time position in 2007. His roles have included program resource writing, acting program coordinator and project management on and offshore with the Chongqing automotive teacher training program project and an alternative fuel projects with both General Motors Holden and Holden Special Vehicle industries. He also is the E-Learning coordinator for the Chisholm automotive centre and has worked in conjunction with both South West TAFE and Vic Roads on alternative fuels online projects.

In 2010 Locandro received a TAFE Development Centre Teaching Fellowship Award to continue his professional development in best practice and up skill his teaching and professional currency.

3. AIMS OF THE FELLOWSHIP PROGRAM

The aim of this Fellowship program was to experience new trends and innovations in alternative fuel sources and drive technologies being explored overseas both in Europe and the USA, combining with hybrid vehicles, such as bio-diesel, ethanol, diesel, hydrogen and CNG/LPG gas. A focus too was on educational training opportunities in specialist areas of E-Mobility, Electric Vehicle (EV) and Hybridisation.

The Fellowship provided the opportunity to gain fundamental skills and knowledge required to facilitate industry, students and TAFE Instructors in training of alternative fuel drive sources and technologies being explored. These include:

- Up skilling of current Industry workforce technicians
- Up skilling of TAFE Instructors
- Apprenticeship training (under AUR12)
- Looking at emerging technologies needs and trends
- Increasing the need for training in sustainable practices
- Up skilling of workplace health and safety (WHS) awareness
- Responsiveness of green technology
- Next generation of low and zero carbon vehicles
- Electric, Hybrid or Alternative fuel vehicles.

4. THE AUSTRALIAN CONTEXT

There seems to be a predominant opinion in both the Australian and overseas automotive industry that more must be done to reduce our reliance on fossil fuels and CO2 emissions. Car manufacturers worldwide are incessantly focusing more resources into developing the next generation of both low and zero carbon vehicles, aimed at addressing this issue, and the increasing cost of fossil fuels and the long term fuel source security.

At present there are four main methods to power vehicles that are driving change: electric or Hybrid, biofuels (e.g. ethanol), alternative fuels (e.g. hydrogen) and fossil fuels (e.g. diesel, LPG and CNG), or some combination of these. All of these fuel types are capable of changing our approach to the technological aspects of vehicle powertrain and there are both positive and negative aspects to such approach changes.

SWOT Analysis

Strengths	Weaknesses	Opportunities	Threats
Meeting emerging Industry needs and demands	Short fall of training support	Expansion of alternative fuel drive sources to other automotive streams	TAFE education and training not meeting Industry needs
Meeting skills shortfalls	Unacceptance and understanding of industry change to meet emerging trends	To collaborate and development educational programs for local and international markets	Loss of training income revenue
Reducing risks to workforces regarding alternative fuel sources systems	Lack of skilled trained workforce in Australia	Design and intergrade programs into other automotive disciplines	Increase in workplace health and safety (WHS) issues due to shortfalls in training.
Identifying specialist diagnostic skills required with alternative fuel sources systems	Increasing sales of alternative fuel vehicles having little impact on training needs for industry future	Introduce this technology to new students.	
Introducing skills and knowledge in to other training areas	Vehicle owners feel they must use only dealership franchise networks due to lack of options.		
Building workforce capabilities			
Building and establishing networking relationships and opportunities			
Building marketable income opportunities via training programs.			

5. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

There are examples of areas in Australian professions industries where there are weaknesses in innovation, skills, knowledge, experience, policies and/or formal organisational structures to support the ongoing successful development and recognition of individuals and the particular sector.

The focus of all ISS Institute Fellowships is on applied research and investigation overseas by Australians. The main objective is to enable enhancement and improvement in skills and practice not currently available or implemented in Australia and the subsequent dissemination and sharing of those skills and recommendations throughout the relevant Australian industry, education, government bodies and the community.

The skill shortfall identified that currently exists is that TAFE instructors and vehicle technicians lack the knowledge and training on how to service, maintain, repair and diagnose alternative fuel drive sources and E-Mobility technologies that are currently available and have been introduced in the Australian automotive marketplace.

The Fellowship provided the opportunity for Locandro to address the following skills enhancement requirements, to record and explore new technologies and educational training opportunities available in Germany, Holland and USA with alternative fuel drive sources combining with hybrid vehicles such as bio-diesel, ethanol, diesel, hydrogen and CNG/LPG gas and in the specialist area of E-Mobility.

Skills Enhancement Area One

Workplace Health and Safety (WHS) - Automotive TAFE instructors and vehicle technicians require the essential knowledge and understanding of current and new safety requirements that are exclusive to alternative fuel drive sources and hybridisation.

Aims:

- Research, record and explore associated information on alternative fuel drive sources combining with hybrid vehicles and Electric Vehicle (EV) and their integrated safety systems
- Research, record and explore the correct procedures to safely disable or deactivate and work on alternative fuel drive sources and hybridisation with HEV and EV high voltage systems so vehicle maintenance and repairs can be carried out
- Research, record and investigate the various types of alternative fuel drive sources combining with hybrid vehicles safety systems being implemented by vehicle manufacturers.

Outcome:

Gain the knowledge and understanding of the working dangers to vehicle technicians and the procedures required to prevent personal injuries whilst working on alternative fuel drive sources and hybridisation.

5. IDENTIFYING THE SKILLS AND KNOWLEDGE ENHANCEMENTS REQUIRED

Skills Enhancement Area Two

Technology Information - Automotive TAFE instructors and vehicle technicians will need to gain knowledge and understanding of the new technologies that are distinctive to alternative fuel drive sources combining with hybrid vehicles and HEV and EV in order to carry out vehicle maintenance and repairs.

Aims:

- Research, explore and record the different types of fuel drive sources that OME manufactures are using such as ethanol, bio/diesel, hydrogen and CNG/LPG gas in vehicle hybridisation
- Research, explore and record transmission and drive train systems innovations
- Research, explore and record vehicle accessories equipment requirements to amalgamate with alternative fuel drive sources
- Research, explore and record energy recovery systems strategies of alternative fuel drive sources with hybrid and EV vehicles
- Research, explore and record future trends and innovations with E-Mobility, electric vehicles (EV), hybrid electric vehicles (HEV) and plug-in-electric vehicles (PHEV) and battery technologies.

Outcome:

Develop knowledge and understanding of the above systems and the equipment, maintenance and repair techniques considered necessary for alternative fuel drive sources combining with hybrid vehicles and HEV and EV.

Skills Enhancement Area Three

Diagnostics Information - Automotive TAFE instructors and vehicle technicians will need to gain knowledge and understanding of the alternative fuel drive sources combining with hybrid vehicles HEV and EV control technologies and the diagnosis procedures needed to identify and test complex vehicle system faults.

Aims:

- Research, explore and record diagnosis procedures for electronic management systems common to alternative fuel drive sources combining with hybrid vehicles HEV and EV systems
- Research, explore and record the analysis, diagnosis and repair developments and innovations techniques currently being used on alternative fuel drive sources combining with hybrid vehicles HEV and EV systems
- Research, explore and record the type of electronic test equipment and their use as required for EV and HEV alternative fuel drive sources combining with hybrid vehicles and EV and HEV for diagnostics procedures.

Outcome:

Increase knowledge and understanding of the diagnosis procedures required to repair necessary alternative fuel drive sources combining with hybrid vehicles and EV and HEV, including E-Mobility.

6. THE INTERNATIONAL EXPERIENCE

Destination 1: Automechanika

Location: Frankfurt Germany

Contact: Ms. Ann-Katrin Klusak, Press Department, Messe Frankfurt

Visit: The World's Leading Trade Fair for the Automotive Industry

Organisation overview: Messe Frankfurt is one of the world's leading trade fair organisers, generating around $545 million euros ($790 million AUS) in sales and employs around 2,000 people worldwide. The Messe Frankfurt Group has a global network of 28 subsidiaries and around 50 international sales partners, allowing it to serve its customers on location in more than 150 countries. Messe Frankfurt events take place in more than 30 locations worldwide. In 2013, Messe Frankfurt organised 113 trade fairs, of which more than half took place outside of Germany. Messe Frankfurt exhibition grounds comprise an area of 578,000 square meters, including 10 exhibition halls and two congress centres. The company is publicly owned, with the City of Frankfurt holding 60 per cent and the State of Hesse 40 per cent.

Automechanika Frankfurt is the world's leading trade fair for the automotive industry. Many exhibitors participate in this event from across the world and provides them an opportunity to showcase wide variety of products from the fields of automotive parts, car washing, workshop and filling-station equipment, IT products and services, accessories and tuning. Automechanika Frankfurt 2014 highlighted new innovations and solutions in the fields of parts, systems, tuning, workshop equipment, bodywork and paintwork, car wash, IT and Management and the latest automobile services. It is an unparalleled event to know about the most recent development and trends in automotive industry.

Automechanika Messe Frankfurt City Germany, September 2014

6. THE INTERNATIONAL EXPERIENCE

Exhibition Highlights:

- A whole exhibition hall dictated to 'Mobility of the Future'
- 'Basic and advance training' in a range of certified courses
- Automechanika Academy with presentations and panel discussions
- 'Automechanika Innovation Awards'
- 'Automechanika Green Directory'
- Heavy vehicle exhibition.

Objectives:

To research and report on the most recent developments and trends in new innovations and solutions in the fields of parts, systems, tuning, workshop equipment and how the automotive industry and training is carry out in Europe. A specific focus is on alternative fuel drive sources such as electric and combining hybrid vehicles with alternative fuels such as bio-diesel, ethanol, diesel, hydrogen and CNG/LPG gas and in the specialist area of E-Mobility.

Safety requirements:

To investigate the underpinning scope of safety training systems requirements necessary for staff, trainers and students when working with alternative fuel drive sources and high voltage electrical systems.

Teaching resources required:

To source tools, equipment, current text books, written resources and look at E-Learning platforms currently being used for training. To investigate which vehicles and components are required for practical training?

Training methodologies:

To identify and evaluate the learning strategy employed by Industry and training equipment providers.

Overall report of Automechanika Messe Frankfurt City Germany, September 2014 [1]

The 23rd Automechanika from 16 to 20 September 2014 was an outstanding showcase for innovations from the international aftermarket. Around 140,000 trade visitors from 173 countries, one in four of them from the workshop sector, took advantage of this opportunity to find out about the latest automotive products and technologies during the five-day event. The fair set a new record with 4,631 companies from 71 countries. The number of international visitors rose by five per cent to around to 60 per cent.

There was around 25 per cent of exhibitors with products and solutions for the commercial vehicle market. Pronounced interest was shown in tomorrow's technologies, e.g. alternative power trains, lightweight construction and energy efficiency.

Specific interest was shown by visitors in subjects such as alternative powertrains, fully automatic digital reception processes, energy efficiency, lightweight construction solutions with previously impossible loading capacities, accessories, customising, car media and 3D printing.

Mr Detlef Braun stated, "More than ever before, Automechanika in Frankfurt has shown itself to be a platform for the presentation of important, future-oriented technologies as the key to tomorrow's

1 http://www.messefrankfurt.com/frankfurt/en/media/mobilityinfrastructure/automechanika/frankfurt/texte/fachschlussbericht-2014.html

developments throughout the entire automotive aftermarket".

Automechanika also presented the latest products and developments from the world market in the commercial-vehicle field, with sustainability and environmental compatibility playing an extremely important role in the commercial-vehicle segment.

More than 50 alternative-drive-train innovators from 12 countries presented their mobility concepts in Hall 10. Together with Pirns Autogas systems and Neste Oil, the German Liquid Gas Association presented a bio version of LPG identified as 'bio propane' – which is LPG made of biomass feedstock – which will be available from 2016 and help further reduce CO2 emissions.

Another area that drew the attention of the Fellow and the number of visitors was the Galleria with a wide-ranging choice of basic and advanced training choices. As a participant the Fellow found that some workshops exceeded his expectations. Messe Frankfurt has created a platform that not only provides specific information on topical issues but also enabled the Fellow and other visitors interested in these subject areas to familiarise with practical aspects of new technologies.

During this expo the Fellow visited a number of different manufacturers' stands, all dealing with different aspects of alternative fuel drive sources. The one area that European manufactures are leaning towards seems to be 'Start Stop' Systems that can save up to 15 per cent of Co2 emissions in traffic congestions.

6. THE INTERNATIONAL EXPERIENCE

Photos of Start stop components

Photos at the exhibition hall dictated to 'Mobility of the Future'

6. THE INTERNATIONAL EXPERIENCE

The next Automechanika Frankfurt will be held from 13 to 17 September, 2016.

As result of attending this excellent Automotive Industry Trade Fair the Fellow will disseminate to his peers the knowledge and networking contacts obtained. He believes students and fellow automotive industry stakeholders have the opportunity to achieve better outcomes.

Appendix 1: Automechanika (Frankfurt Germany) 2014 Exhibitor Statistics

Destination 2: Koning Willem 1 College

Location: Hertogenbosch Netherlands

Contact: Mr. Gradus Vanmaaren, Head of Automotive & Logistics department

Visit: College training facilities and teaching methodologies

Organisation overview:

Koning Willem 1 College is a progressive Regional Education Centre offering Primary and Secondary Vocational and Formal Education. The school offers a good, solid and contemporary education and stands for development of high standards of education. It develops its staff and teachers to be leaders in their fields.

Key Statistics:

Koning Willem I College (KWIC) is one of the biggest Regional Education Centres (ROC) in the Netherlands, with 13,000 students and 1,200 staff. A large concentration of courses on a campus-like location has enabled KWIC to develop into a community college with a clear goals: to develop into one of the best colleges in the world, both for the content of its education and its personnel policy.

The department of Design, Art and Technology offers a unique combination of creativity and technology. In August 2001, the College founded an Academy of Information and Communication Technology (ICT) offering a complete range of ICT courses. KWIC's showpieces include a hotel school, courses in management, tourism and theatre and a preparatory course for academies of art and design.

In cooperation with other organisations, KWIC has developed as a dynamic, high-tech knowledge-based organisation; the School for the Future. The ambition of the School for the Future is to develop into the leading centre for E-Learning and an important centre of creative thinking. Its congresses, seminars, workshops and master classes enable it to function as a knowledge platform for education and industry with links with comparable establishments in a large number of European countries, the United States and Asia. Koning Willem I College's role is to build bridges between education and industry and to encourage cooperation between the various knowledge-based establishments.

Objective:

6. THE INTERNATIONAL EXPERIENCE

To report and observe the teaching methodologies used in the field of automotive industry training carried out in secondary colleges in Netherlands, with a specific focus on alternative fuel drive sources such as electric and combining hybrid vehicles with alternative fuels.

Safety requirements:

To investigate the underpinning scope of safety training requirements used for instructors and students when working with alternative fuel drive sources and high voltage electrical systems.

Teaching resources required:

To source current text books, training resources and look at E-Learning platforms currently being used for training. To investigate which vehicles and components are required for practical training?

Training methodologies:

To identify and evaluate the learning strategies employed by Koning Willem 1 College in training of alternative fuel drive sources and high voltage electrical systems.

The Fellow was fortunate enough to visit Koning Willem I College while in the Netherlands with Mr and Mrs Van Batenburg who conducted two classes on Hybrid awareness. Koning Willem I College has established an ongoing relationship with Mr Craig Van Batesburg's company ACDC and has instructors visit Worcester, Massachusetts, USA and attend his 'Up your Voltage course'. Mr Craig Van Batenburg also conducts training sessions with Koning Willem I College students on a yearly basis which the students enjoy and engage with his presentation. The College has an adaptive approach with hybrid and alternative powertrain technologies, by using both industry and subject professionals and state of the art teaching resources to help deliver a blended learning approach.

Photos of Koning Willem I College training sessions, facilities and the Automotive Instructors team September 2014

In closing, the Fellow aims to disseminate this knowledge and training methodology to his peers, students and fellow automotive industry stakeholders to achieve better outcomes.

6. THE INTERNATIONAL EXPERIENCE

Destination 3: Lucas-Nuelle

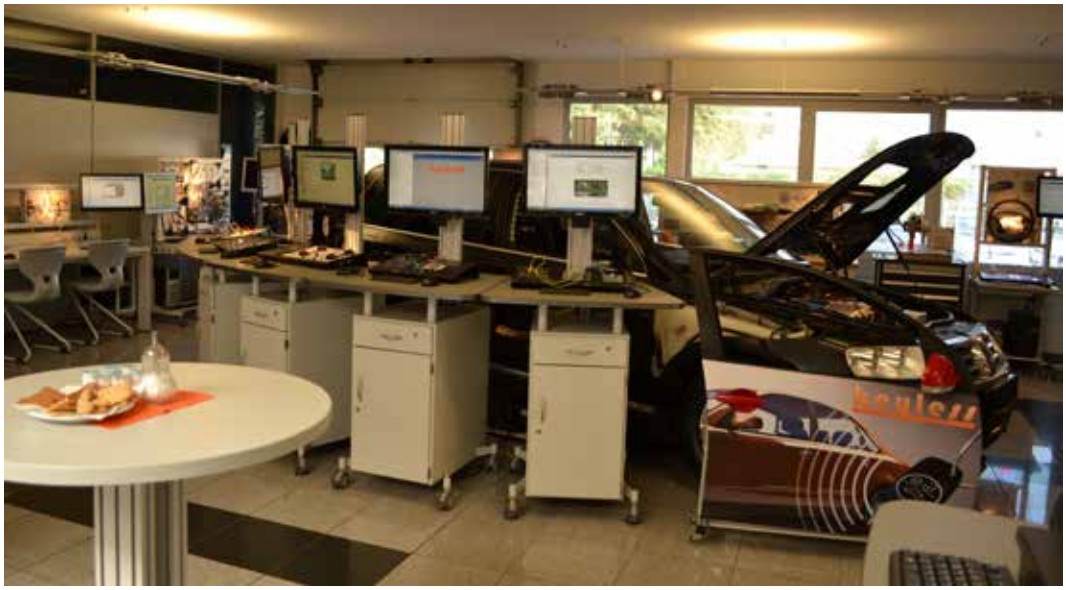
Location: Kerpen, Germany

Contact: Mr Daniel Brown, Manager of the Lucas-Nuelle Academy

Visit: Mobile-Multimedia-Desktop Laboratory and E-Learning system

Organisation overview:

The Lucas-Nulle company for more than 40 years has been a leader in the development, manufacture and marketing of high-quality, state-of-the-art training systems and education equipment to further advance technical, engineering and vocational education. In addition to course offerings covering a wide range of basic theoretical material, project-oriented and didactic training receives special focus. Lucas-Nulle also works with more than 60 sales partners worldwide to be a truly global player in the world market.



Photos of the days event at Lucas-Nuelle head office Kerpen Germany, September 2014

Objective:

To research and report on the most recent developments and trends in new innovations and solutions in the fields of automotive industry training carried out in Europe, with a specific focus on alternative fuel drive sources such as electric and hybrid vehicles combinations.

6. THE INTERNATIONAL EXPERIENCE

Safety requirements:

To investigate the underpinning scope of safety training requirements necessary for both instructors and students when working with alternative fuel drive sources such as electric and hybrid vehicles combinations.

Training resources required:

To source and evaluate current resources and look at E-Learning platforms currently being used for training and investigate components simulators required for practical training.

Training methodologies:

To identify and evaluate the learning strategy employed by Lucas-Nuelle.

The Fellow was fortunate enough to spend a full day at Lucas-Nuelle head office in Kerpen, Germany with Mr Daniel Brown, Manager of the Lucas-Nuelle Academy. He was able to give the Fellow a full guided tour of the production plant, from the high tech construction of their specialised equipment to the demonstration of Lucas-Nuelle state-of-the-art training systems and illustrate how automotive technology continues to be a driver of innovation.

Lucas-Nuelle training systems are able to further assist in training today's technicians to comprehend and become more familiar with today's new complex technology. All fields of technology can now be found integrated in today's automotive technology. Lucas-Nuelle state-of-the-art training systems includes:

- Electrical engineering and electronics
- Mechanical engineering
- Pneumatics and hydraulics
- IT technology.

Within these innumerable technologies the educational concept behind Lucas-Nuelle training systems, can play an important role in training alternative fuel drive sources. By using a blended delivery methodology that includes hands-on training and up-to-date multimedia-based and interactive elements, Lucas-Nuelle is at the forefront of training in the automotive sector.

Lucas-Nuelle field of training is set into the following topics:

- Fundamentals of electrical engineering and electronics, electronics trainer
- CAN-bus trainer, LIN-bus trainer, MOST-bus trainer
- Automotive engineering, automotive trainer
- Engine management systems, engine management trainer
- Electro-mechanical systems in the motor vehicle, electro-mechanical trainer
- E-mobility trainer, new drive trainer, hybrid trainer.

High voltage a new training content

Automotive technology is developing rapidly: hybrid and electric vehicles, high-voltage technologies, new lightweight materials and modern repair methods for bodies are becoming more imperative. In Germany, new learning content and a revised training structure are preparing their technicians for todays and tomorrow's developing automotive market.

E-Mobility for cars

Lucas-Nuelle components simulators for E-Mobility are able to test and measure vehicles with hybrid, electric and fuel cell drive. The following drive types are covered:

- Serial hybrid drive with plug-in
- Parallel hybrid drive with plug-in
- Serial-parallel hybrid with plug-in
- Electric vehicle
- Fuel cell vehicle.

High quality systems for vocational training

Lucas-Nulle training systems are highly equipped for both vocational and industry training. With their unitrain systems delivering a wide underpinning knowledge, importance is also placed on project-oriented vocational training with an exceptionally-constructed educational focus. Their training systems uses theory and application and can turn knowledge into know-how and skill. The Lucas-Nulle objective is to create a system to not just motivate students but help them in using training equipment and the accompanying software. Their training systems are designed as self-directed or in small groups. The equipment used is broken-down into small segments so that the students can engage the theoretical aspects step-by-step and in parallel to practical hands-on exercises.

Examination tool for instructors

Lucas-Nulle training systems in combination with their classroom manager administration tool, Lab Soft, helps make lesson planning and evaluation easier for instructors. Its student version of the courses are linked with each other within the PC network. The instructor version, that is also part of this network, continuously evaluates the work of each student and the whole class in the background and stores the results in a database. The instructor can carry out a very quick analysis of the level attained by the whole class or each individual student at any time.

Training methodologies

Lucas-Nulle training systems allows clear evaluation of completed student courses and practice tests, therefore displays what level the student and the class group has reached. The individual data can also provide information about who is lagging behind and who is principally capable. With this information instructors are able to evaluate exactly which subject areas that students need to review, who requires extra support and those who are ready to move onto more challenging tasks.

In closing, the Fellow would like to thank personally Mr Daniel Brown, Manager of the Lucas-Nuelle Academy for his help and assistance with his study research. Currently Chisholm has set up Lucas-Nuelle training systems that the Fellow will disseminate to his peers, students and fellow automotive industry stakeholders to achieve better outcomes in alternative fuel drive sources such as electric, hybrid and E-mobility vehicle combinations.

6. THE INTERNATIONAL EXPERIENCE

Destination 4: Automotive Career Development Centre (ACDC)

Location: Worcester, Massachusetts, USA

Contact: Mr. Craig Van Batenburg, CEO, Automotive Career Development Centre (ACDC)

Visit: To shadow Mr Van Batenburg and gather knowledge and information in the field of hybrid/ electric vehicles.

Organisation overview:

ACDC is a leading independent USA automotive training company based in Worcester, Massachusetts that specialises in Hybrid and Electric Vehicle training for the aftermarket and independent repair sector.

Organisation overview:

Mr. Craig Van Batenburg started the Automotive Career Development Center (ACDC) in 1998 while still running his automotive repair workshop that was directly opposite. Originally ACDC was located at 19 Wells Street in Worcester, Massachusetts. Classes such as State Emission and many other technical and management courses were conducted there. Van Batenburg and other local trainers facilitated a number of classes there and it grew quickly as a leader in training for the aftermarket and independent repair sector.

In 2004 Batenburg closed his ACDC training center building and his automotive repair workshop, to focus on Hybrid technology. He had found his passion and embarked around the globe to train and educate those who needed hybrid training. Van Batenburg has a new office only ten house away from his home with more space and room for all the hybrids, parts and associated training materials. On November 21, 2014 ACDC's opened their new training center back where it all began at 19 Wells Street in Worcester, Massachusetts.

Objective:

To research and report on the most recent developments and trends in new innovations and solutions in the fields of automotive industry training in the aftermarket sector carried out in USA, with a specific focus on alternative drive sources such as electric and hybridisation.

Safety requirements:

To investigate the underpinning scope of safety training requirements necessary for trainers and automotive technicians when working with high voltage electrical systems.

Teaching resources required:

To source current text books, written resources and look at E-Learning platforms currently being used for training and to investigate which vehicles and components are required for practical training.

Training methodologies:

To identify and evaluate the learning strategy employed by the aftermarket sector training provider.

Safety precautions and PPE requirements:

Van Batenburg as a leading authority in Electric/ Hybrid automotive repairs, highly recommends that precautions be taken when working on Electric/ Hybrid vehicles that can be dangerous. Items required for safe training necessary for trainers and automotive technicians when working with high voltage electrical systems are:

- Class 0 high voltage gloves rated to 1,000 volts. These gloves are required for disabling the battery and handling high voltage parts to evade possible electrocution
- Safety glasses. In the case of a defective meters which could actually explode when you're checking voltage throughout the vehicle
- Protective body suit. When dealing with electric car batteries that contain electrolyte chemicals that are toxic
- Removal of jewelry. Decreasing the possibility of electrocution
- Fiberglass pole. Some workshops in the USA and Europe have insulated poles that can be used to pull technicians away from the vehicle if they have been electrocuted.

Specialised Tools and Equipment:

- Insulated hand tools. To stop possible shorting out occurring
- Category III volt-ohm meter rated to 1000 volts. This meter is required to be able to check vehicle's high voltage levels
- Battery charging equipment. Charging stations that are able to charge electric battery vehicles
- Non-metal workbench. Wooden or plastic-covered benches must be used when working with high voltage parts. Thereby not allowing the workbenches to become conductive of electricity when benches become oily
- Go jacks. Go jacks or wheel trollies must be used on the drive wheels for all electric cars. Electric vehicles use the drag on brakes to create electricity. If pushed or towing an electric vehicle the drive wheels can charge the vehicle's inverters, which can cause problems.

6. THE INTERNATIONAL EXPERIENCE

Training methodologies:

- OME manufacturer's basic procedures. Van Batenburg also recommends that vehicle manufacturer recommendations and procedures are followed as per outlined in their service manuals when vehicles are in the workshop and the recommended repair processes and methods understood before working on the vehicle
- OEM certified repair programs. Some automotive manufacturers require technicians to become OEM-certified in order to work on and replace wiring harnesses or other parts of the high-energy system
- Disable the electrical system. To be done to isolate the current to the high voltage battery.
- Use the correct oil. All electric vehicles have high voltage air conditioning compressors; use the factory oil replacement or a good, known equivalent for those compressors. The incorrect type of oil will contaminate and damage the system thereby cause it to shut down
- Paint (Oven) and panels repairs. The batteries in electric vehicles must never be exposed to temperatures above 65 degrees Celsius
- Testing voltage throughout the vehicle prior to working on it. Vehicle manufacturer recommendations state - Wait five to 10 minutes after the vehicle is turned off before starting work on the vehicle; technicians must test components to ensure the vehicle's voltage level is at zero before beginning any work to vehicle
- Torque setting on all connections. High voltage connections must be torqued exactly to the correct specification. Any loose, high-voltage cable could create a short and or fire
- High Voltage cables. Ensure you know were these cables are located, before cutting or repairs are carried out. This will vary from vehicle to vehicle.

"High voltage cables are orange. Blue-colored cables represent an intermediate amount of voltage, between 36 and 42 volts"

During a number of discussions, Van Batenburg believes, "That repairing electric vehicles is nothing that should cause you concern, as long as you know what you need to know". Technology in electric vehicles are changing rapidly, so it's important for technicians to be up-to-date with this new technology. It would be dangerous to assume that, working on one type of hybrid vehicle, that you can use the same procedure for all types of electric vehicles. Electric vehicles are diverse: pure electric, extended range electric, petrol, diesel and LPG/ Electric hybrid. Repair procedures will vary form type and model. Also Van Batenburg mentioned to the Fellow that knowledge is the most important factor in becoming comfortable with electric vehicles. That fear of the unknown completely goes away once people acquire the proper training. Training isn't just for technicians; estimators and insurers writing

damage reports need to know the information as well. All types of repairers need to know where items are located in these vehicles. Some of these elements include the inverter, the high-voltage battery, the service-disconnect system, the electric air conditioning system and where all the main cables are located.

Vehicle manufacturers:

OEM websites also have a lot of information related to the disconnection for emergency first responders (e.g. Toyota). Information about how to disable electrical systems and where electrical cables are located is applicable to collision repairers.

Text books:

ACDC offers many text books, training manuals and DVDs for everything automotive and collision repairers need to know about Hybrid EV fuel vehicles.

In closing, the Fellow would like to thank personally Van Batenburg, CEO, Automotive Career Development Centre (ACDC) and his lovely wife Deb for their help and professional support with this research. The Fellow was lucky enough to spend time touring through Germany at 'Automechanika' and the Netherlands were he conducted Hybrid awareness classes at Koning Willem I College. They both took the Fellow under their wing and he grew both as a person and scope of knowledge in the Hybrid field. After returning home to Australia for two weeks, he headed to Worcester, Massachusetts where they (ACDC) hosted him for two weeks before heading to Las Vegas for Industry week. In that time he was able to spend one-on-one time with Van Batenburg who has become his mentor and taught the Fellow all about the hybrid industry. The Fellow will disseminate Van Batesburg's knowledge and 'hands on approach' to his peers, students and fellow automotive industry stakeholders to enable them to achieve better outcomes in this automotive sector.

Destination 5: Alt Wheels Fleet Day

Location: Norwood, Massachusetts, USA

Contact: Mr Alison Sanders and Mr Steve Connors, Alt Wheels co-founders

Visit: To report the developments and trends in new innovations in alternative fuel drive sources fleet vehicle management in East Coast of America.

Organisation overview:

Alt Wheels Fleet Day is the largest meeting of corporate and municipal Fleet Managers on the East Coast of America. The day consisted of panels, exhibits and vehicles offering a showcase of alternative transportation solutions — from concept vehicles, to vehicles that are available and affordable today.

Fleet Day was hosted at the Four Points by Sheraton Hotel and conference centre in Norwood, MA in their state-of-the-art conference space with a large outdoor vehicle display. This event was showcasing and informing attendees on the latest in fleet transportation technologies, alternative fuels and fleet management practices.

Key Stakeholders in this event included:

- Braun's express
- Staples Inc.
- Voltrek
- MassPort
- Town of Framingham
- University of Mass Amherst
- National Grid
- AVSG
- EPA 1
- Mass DOT
- XL Hybrids
- City of Boston Central Fleet
- UMASS
- Cape Cod Biodiesel
- Meridian Associates
- Saving fuel with Smart Way technology
- Massachusetts Clean Cities Coalition.


ARE YOU
READY


VANTAGE
International
DRIVEN TO PERFORM
TRUCKALL & VANGO

6. THE INTERNATIONAL EXPERIENCE

Photos of the Alt Wheels Fleet Day event Norwood, Massachusetts USA October 2014

Objectives:

To research and report on the most recent developments and trends in new innovations and solutions in the fields of alternative fuel drive sources for fleet vehicle management adopted in the east coast of America.

Are OEM still committed to alternative fuels?

Mr Chris Lemoine [2](district sales manager, eastern American region for Hino Trucks - a part of the Toyota group) stated, "That Hino had invested nearly a billion dollars (US) into research and development of its six generation Hybrid technology and was total committed in reducing its carbon footprint".

Since 1991, Hino has sold over 12,000 vehicles worldwide using its Hybrid technology, making them an industry leader in commercial hybrid market. Fleet operators are seeing a fuel savings up 30 per cent compared to diesel only fleets thereby lowering running costs and being environmentally friendly and reducing the reliance on fossil fuel.

2 Guest speaker at the Alt Wheels Fleet Day October 2014

6. THE INTERNATIONAL EXPERIENCE

Medium and light trucks on display

Also both John Coleman (Ford motor company) and Jay Ferraro (General motors) who were also part of the panel list at the Alt Wheels fleet day forum stated that their market share was also totally committed to alternative fuel drive sources for fleet vehicles.

Liquefied Petroleum Gas (LPG - Propane in the USA) is the most widely used alternative fuel used in the USA. LPG has a strong economic and environmental advantages and its benefits are as a competitive fuel for fleets around the USA.

LPG offers:

- Lower emissions
- Lower running costs
- Country wide infrastructure
- Proven technology
- Abundant supply.


7043
Cumberland

6. THE INTERNATIONAL EXPERIENCE

LNG and CNG Trucks on display during the event

Also discussed was the USA leading the charge in Liquefied Natural Gas (LNG) fleet conversion, with extensive refuelling network expansion plans also well underway? Original Equipment Manufacturers (OEMs) are also committing to the LNG solution, with some offering LNG equipment solutions now and many more moving to develop LNG powered prime movers for tomorrow.

Also given the current economic environment in the United States and with fuel costs representing up to 40 per cent of one typical heavy-duty, on-road truck operating fuel costs, the competitive incentive to increase fuel economy by the transport industry in the United States is perhaps a signpost for Australia to follow.

The Shell Company is working closely with a number of partners to help develop LNG as a viable, cost competitive fuelling option. Shell has strong links in technical, regulatory and OEM partnerships to bring value to end users. For example, in North America, Shell is working on LNG projects with Wartsila North America in developing larger engines to run on LNG. Shell has also recently announced a global partnership with Volvo to bring LNG powered vehicles to the market.

LNG in Australia:

Natural gas, and by extension LNG, is an abundant natural resource in Australia. Natural gas offers the opportunity to tap into a local energy source that will help secure Australia's future energy requirements. Shell has significant investments in natural gas in Australia seeing it as an important part of the energy synthesis.

Hydrogen:

Hydrogen as an alternative fuel source was discussed during this summit and has the potential to revolutionise the transportation system. It is more efficient, for conventional internal combustion engine vehicles and produces no harmful tailpipe exhaust emission. Fuel cell vehicles and the hydrogen infrastructure to fuel them are in an early stage of deployment. The US Department of Energy is leading government and industry efforts to make hydrogen-powered vehicles a more affordable, environmentally friendly and a safe transportation option.

In closing, the Alt Wheels Fleet Day showcased how recent developments and trends in new innovations and solutions in the fields of alternative fuel drive sources for fleet vehicle management are shaping the east coast of America. The knowledge and networking that the Fellow was able to obtain, will enable him to disseminate this to his peers, students and fellow automotive industry stakeholders to achieve better outcomes for the Industry.

Appendix2: Massachusetts (USA 2014) Clean Cities Coalition Key statics

Destination 6: Worcester Technical High School

Location: Worcester, Massachusetts, USA

Contact: Mr Clifford Worthley, head of the automotive department

Visit: View Facilities, discuss teaching methodologies and work with students on a hybrid vehicle project under the guidance of ACDC.

Organisation overview:

Worcester Tech's Automotive Technology program provides students with the basic skills and knowledge needed to become a successful entry level automotive technician. Worcester Tech's Automotive Technology program combines academic instruction with live 'hands on' work experience to prepare the student for entry level automotive technician positions. A strong curriculum is the foundation of this successful program. This program trains students as technicians who are able to service and repair automobiles, vans and light trucks. The program offers experience using the latest equipment available to analyse and diagnose automotive problems.

Also Worcester Technical High School was awarded number one technical school in the whole of USA for 2014.

Key statics:

- Worcester Technical High School has 1,366 students in grades (years) 9 to12
- The student teacher ratio of 11:1 is lower than the MA average of 14:1
- Minority enrolment is 52 per cent of the student body (majority Hispanic), which is more than the state average of 34 per cent.

Worcester Technical Automotive Technology program is NATEF (National Automotive Technicians Education Foundation) certified and also affiliated with the AYES (Automotive Youth Educational System) initiative. Worcester Technical High School as AYES serves in a liaison capacity while providing mentorships, apprenticeships and placement opportunities within the dealerships and service providers in the Worcester, Massachusetts area.

Mr Clifford Worthley, head of the automotive department stated,[3] "With today's automotive vehicles they have become more complex and servicing and maintaining their complicated systems requires a comprehensive understanding of each system and how their components function".

Worcester Technical Automotive Technology program provides its students with the basic skills and

3 Interviewed while working on case study with students at Worcester Technical High School October 2014

knowledge required to become a successful entry level automotive technician. As an automotive service technician they must have advance skills in maths, English, communications and electronics, as well as the ability to diagnose complex automotive faults.

There program tutors students as trainee technicians who are able to service and repair cars, vans and light trucks. Their program offers experience using the latest equipment available to analyse and diagnose automotive faults. Worcester Technical Automotive Technology training methodologies combines academic instruction with live hands on practical workshop experience to prepare its students to be work ready for entry level automotive technician positions. In conjunction with a strong curriculum this reinforces the foundation of a successful program.

Objectives:

To research and report on the trends of new innovations and training methodologies adopted by Worcester Technical High School MA in USA in the area of automotive training.

Carry out a case study:

To work with a group of three students on a hybrid vehicle project to investigate the underpinning scope of safety training requirements necessary for both trainers and students when working with high voltage electrical systems. Also systematically work as a team to check, test, diagnose and repair the vehicle over a two to three day period under the guidance of Mr Craig Van Batenburg and document all outcomes.

6. THE INTERNATIONAL EXPERIENCE

Photos of the case study conducted at Worcester Technical Automotive department October 2014

A 2005 Ford escape hybrid SUV was donated to Worcester Technical Automotive department in late 2013.The vehicle was running poorly and after further analyse it was diagnosed with number three piston damage. The department decided to purchase a second hand engine that was later installed. After all repairs were carried out, checked and double checked, the vehicle would not start, thereby pointing to a problem with the high voltage system.

The Fellow, under the guidance of Van Batenburg, was asked to facilitate with three nominated students to conduct testing and diagnose the fault.

The Fellow guided the students to carry out tests and checks using the correct safety and test equipment over a two day period to finally diagnose a faulty HV Battery pack. The Fellow was fortunate enough to be driving the same vehicle, a 2005 Ford escape hybrid SUV, that was a fleet car used for training by ACDC. The students safely disconnected this HV Battery pack, installed it to the school's faulty one and the vehicle started and ran.

In closing, the Fellow would like to thank all involved for this experience and the Fellow will aim to disseminate this case study to his peers, students and fellow automotive industry stakeholders.

Destination 7: BigR/ReMa Tec USA

Location: Rio Hotel & Convention Centre, Las Vegas, Nevada, USA

Contact: Ms Eva Barten, Marketing & Communications Manager

Visit: Over three days visit those who shape the remanufacturing automotive aftermarket.

Organisation overview:

BigR/ReMaTec USA is the largest automotive remanufacturing event in North America, and in 2014 it combined with the Netherlands and other European countries as a partnership to give a thorough overview of present business and technology trends and worldwide developments within the total remanufacturing industry.

Objective:

To research and report on the most recent developments and trends in new innovations and solutions in the fields of automotive remanufacturing parts in North America, Netherlands and other European countries, with a specific focus on alternative fuel drive sources.

Overview:

The remanufacturing industry is huge business and getting larger all the time. On the heels of the success of the remanufacturing event in Europe, APRA and ReMaTec USA brought their formula to Las Vegas. The inaugural Big R/ReMaTec USA trade show, took place in November 2014 just prior to Industry Week.

Teaching resources required:

To source and investigate what remanufacturing vehicle components are required for practical training when working with alternative fuel drive sources and high voltage electrical systems.

6. THE INTERNATIONAL EXPERIENCE

Focused on Remanufacturing

The three day event was positioned as the number one remanufacture show in North America as it was focused solely on remanufacturing. Big R/ReMaTec USA enabled both local and international companies to gain access to this rapidly developing market. With a strong line-up of seminars and technical sessions, a large amount of people were attracted from around the world. A theatre type concept, that featured 30-minute education sessions, offered attendees a great opportunity to interaction with presenters and gather knowledge.

The rapidly growing remanufacturing industry has seen more governments, authorities, organisations and businesses around the world turn to remanufacturing for its unique combination of quality, sustainability, cost-effectiveness and employability. According to the United States International Trade Commission (USITC) report, "The USA is the largest remanufacturer in the world and from 2009 grew by 15 per cent to more than $43 billion (US), supporting 180,000 full-time US jobs".[4]

Remanufactured 9 speed transmission
Remanufactured Hybrid HV Air Conditioning compressor

Key statics: [5]

	Annual volume (Units):	Annual co2 savings (tons):
Automotive (Cars & Vans)	22,313,000	270,000
Heavy Duty Components	3,590,000	279,000
Heavy Duty Tyres	3,800,000	285,000
Total	29.6 Million	834,000

European Automotive Remanufacturing, 2012 [6]

4 According to the United States International Trade Commission (USITC) report 2013.

5 http://www.apra-europe.org/main.php?target=home

6 http://www.apra-europe.org/main.php?target=home

New Opportunities:

With new opportunities and the emphasis on finding environmental solutions, remanufacturing must be been considered to benefit the Automotive industry. With the green momentum sweeping the globe, the remanufacturing sector can capitalise and offer quality, cost effectiveness and new jobs in the automotive sector and embrace the rapidly changing technology as automotive and alternative powertrain components become high tech electronic or mechatronic units.

In closing, remanufactured vehicle components should be used for practical training when working with alternative fuel drive sources and high voltage electrical systems. The Fellow will disseminate this information to his peers, students and fellow automotive industry stakeholders to achieve better outcomes and reduce the environmental impact on the world resource.

Destination 8: AAPEX

Location: Sands Expo Centre, Las Vegas, Nevada, USA

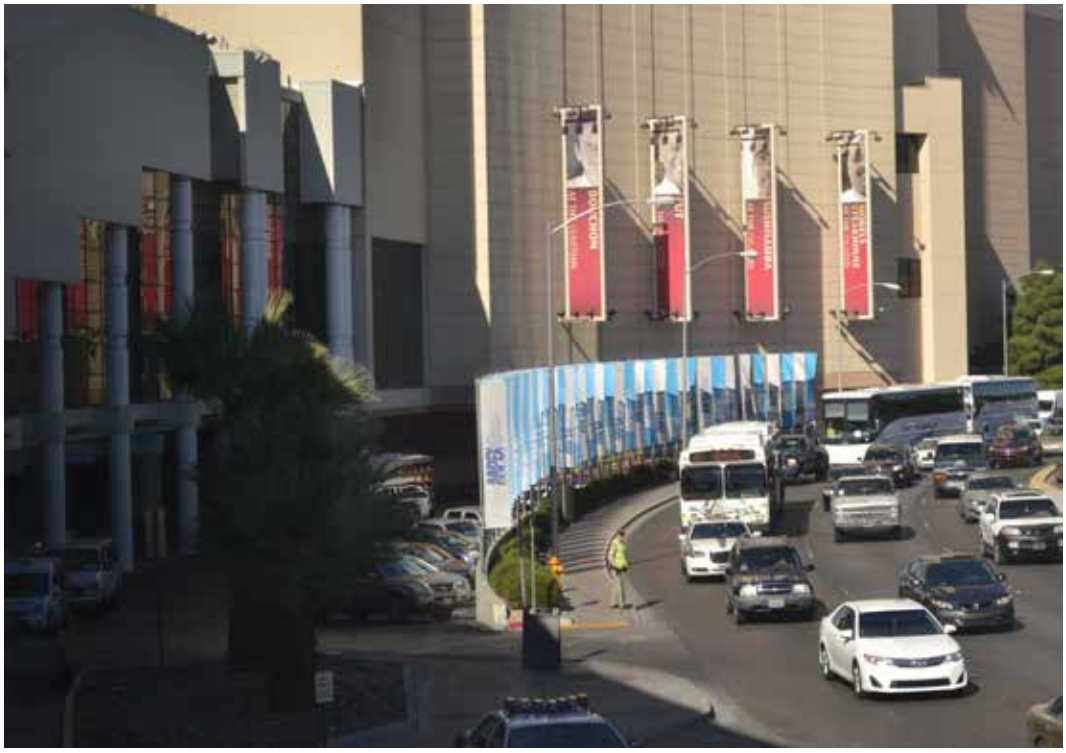
Contact: Mr Milton Dunn, Senior Event Service Manager

Visit: APPEX (Automotive Aftermarket Product Expo) over four days to source and investigate those who shape the future of the automotive aftermarket where brands, markets and economies converge.

Organisation overview:

AAPEX gave the Fellow and other attendees access to the leading innovator industry, top universities, the media, trade and research groups, governments and those who defy classification.

New products in every category with a number of new suppliers from around the world joined over 5,000 exhibitors in areas such as research, trends and new education. Manufacturers and suppliers of air conditioning, automotive lighting, electrical systems and batteries, cooling systems, friction and brake systems, undercar, new and remanufactured replacement parts, suspension and front end, engine and transmission parts, appearance chemicals and functional fluids, equipment and tools (including diagnostic, hand tools, machine shop, and service and installation) computer systems and software, paint and body and retail warehouse fixtures were present.



Objectives:

To research and report the most recent developments and trends in innovations and solutions in new products in every category of new suppliers from around the world - new research, new trends and new education with a specific focus on alternative fuel drive sources.

Safety requirements:

To investigate the underpinning scope of safety training requirements necessary for staff, trainers and students when working with new products with a specific focus on alternative fuel drive sources.

Teaching resources required:

To source current text books, written resources and look at E-Learning platforms currently being used for training. To investigate vehicles and components required for practical training.

Training methodologies:

To identify and evaluate the learning strategy employed by Industry and training equipment providers.

AAPEX featured more than 2,400 exhibitors, 5,000 booths, nearly 50 AAPEX Edu sessions and 39,000 targeted buyers. More than 130,000 automotive aftermarket professionals from nearly 125 countries attended the 2014 event.

Several well-known race car drivers, popular TV personalities and noted American celebrities visited the exhibitors' booths during the 2014 Automotive Aftermarket Products Expo (AAPEX). Race car drivers making appearances at AAPEX include Landon Cassill, Justin Boston, Michael Waltrip, Richard Petty, Shea Holbrook, Ken Schrader, Danica Patrick, Trevor Bayne and former NASCAR drivers Bill Venturini, Jeremy McGrath (seven-time AMA Supercross Champion) and Dennis Anderson (Monster Jam Driver) with TV personalities Bogi Lateiner, All Girls Garage; Willie Robertson, Duck Dynasty; Sam Memmolo and Dave Bowman, Velocity's Motorhead Garage; and Richard Rawling, Fast N/Loud and the Discovery Channel.

During this expo the Fellow visited the Medtronic's stand that are leaders in advanced battery management. It has become quite apparent that the hybrid and electric vehicle (EV) markets are fast-growing. Medtronic's is leading the way by working closely with manufacturers to develop solutions that match the complexity of new battery and electrical systems. Medtronic's in 2010 launched the HYB-1000 - the first Hybrid Battery System Analyser for service technicians. Later that year, Medtronic's delivered its first essential tool for an EV OEM - the GRX-5000 EV Battery Module Diagnostic Station. The GRX-5000 enables trainers and technicians to perform module-level service on Li-on EV battery modules that are part of the Nissan Leaf battery pack.

Some of Medtronic's equipment on display

6. THE INTERNATIONAL EXPERIENCE

The 2014 AAPEX Edu program had a number industry sessions. The Fellow was able to attend a presentation by Mr Matt Overbeck for Dorman Products. This session gave an overview about:

- Hybrid Battery Overview
- Proper Handling and Safety
- Diagnosing a Bad Battery
- Tools Needed
- Uninstalling the Old Battery
- Installing the New Battery
- Confirming New Battery Function
- Core Return Process.

The presentation was both interesting and very informative. Mr. Overbeck stated, “Safety is an important concern when working with the electrical systems of hybrid vehicles, particularly when removing and installing hybrid vehicle batteries. Because of the high voltage that the batteries generate, removing and installing hybrid batteries is an inherently dangerous activity and can lead to serious or even fatal injuries. Suitable training is essential before removing, installing, or servicing this product which should only be attempted by a qualified technician”.

In closing, the 2014 AAPEX expo showcased practical training and high quality components and testing equipment when working with alternative fuel drive sources and high voltage electrical systems. The Fellow will aim to disseminate this information to his peers, students and fellow automotive industry stakeholders to achieve better outcomes and reduce the environmental impact on the world resources.

Destination 9: SEMA

Location: Las Vegas Convention Centre, Las Vegas, Nevada, USA

Contact: Mr Della Domingo, Media Manger

Visit: SEMA over a four day period to create important business connections and network with the industry's leaders.

Organisation overview:

Specialty Equipment Market Association (SEMA) of the automobile aftermarket was formed in 1963 by Roy Richter, Ed Iskenderian, Willie Garner, Bob Hedman, Robert E. Wyman, John Bartlett, Phil Weiand, Jr., Al Segal, Dean Moon, and Vic Edelbrock, Jr. and now consists of 6,383 companies worldwide, bringing together aftermarket manufacturers, original equipment manufacturers, media, car dealers, specialty equipment distributors, installers, retailers and restoration specialists.

Originally the SEMA acronym stood for Speed Equipment Manufacturing Association. In 1970, government regulations became an issue and the name was changed to Specialty Equipment Market Association to improve the overall image of the association. The SEMA Show is the premier automotive specialty products trade event in the world which draws the industry's brightest minds and most up-to-date products to one place, the Las Vegas Convention Center. In addition, the SEMA show provided attendees with educational seminars, product demonstrations, special events, networking opportunities and more.

Key statics:

The SEMA show took place from Tuesday 4th November to Friday 7th November, 2014 and drew more than 60,000 domestic and international buyers. The show displays were divided into 12 sections, with a new products Showcase featuring nearly 2,000 newly introduced parts, tools and components. In

addition, the SEMA show provided attendees with educational seminars, product demonstrations, special events and networking opportunities.

All leading automobile manufacturers were represented and presented their latest trends, shapes and colours in the industry. Products in this $30 billion-a-year (US) ($35 billion AUS) industry included performance and racing components, cosmetic and functional accessories, wheels and tires, mobile electronics, safety products, restoration parts, handling equipment, drivetrain parts and more. The industry covers Hot rods, muscle cars, classics, luxury vehicles, sport compacts, street rods, light trucks (off-road and sport trucks) SUVs, Custom and recreational vehicles.

The SEMA show is the premier automotive specialty products trade event in the world that is not open to the general public. It draws the industry's brightest minds and hottest products to one place, the Las Vegas Convention Centre. As part of the Automotive Aftermarket Industry Week (AAIW), the SEMA show attracts more than 100,000 industry leaders from more than 100 countries for unlimited profit opportunities in the automotive, truck and SUV, power sports and RV markets. This event in northern America is divided into 12 sections: Business Services, Collision Repair & Refinish and Global Tyre Expo Powered by TIA, Hot Rod Alley, Mobile Electronics & Technology, Power sports & Utility Vehicles, Racing & Performance, Restoration Marketplace, Restyling & Car Care Accessories, Tools & Equipment, Trucks, SUVs & Off-Road, Wheels & Accessories.

Photo of the 2014 SEMA Show

The SEMA show is an event that brings together all aspects of the Automotive spectrum, from the outranges to the total indulgences. It showcases all of the major automotive OME manufactures such as Ford, GM, Toyota, Hyundai and Honda (that presented its CRZ –HDP Hybrid and a F1 Hybrid race car from the 2012 series).

Hybrid vehicles displayed during the SEMA 2014 show

6. THE INTERNATIONAL EXPERIENCE

Concluding remarks for the international experience

The Fellowship enabled the study of developments and trends in new innovations and solutions in the fields of parts, systems, tuning, workshop equipment, safety issues and how the automotive industry and training is carried out with a specific focus on alternative fuel drive sources. The Fellow's learnings have the potential to impact the Australian Automotive training and repair industry.

The Fellow believes technical information supporting alternative fuel drive sources technology are more accessible in both Europe and the USA market. In the Australian training sector and the automotive repair industry there is a lack of supporting resources compared to our overseas partners. Technical equipment is accessible for the alternative fuel drive sources in the Australian automotive industry, but is not seen as essential. The alternative fuel drive sources using high voltage systems require some specialist equipment that are available in Australia and via overseas distributors.

The main cause for concern is a deficiency of training available to the Automotive Instructors and the Automotive aftermarket industry on both product and equipment use, for alternative fuel drive sources specifically High voltage/ Hybrid vehicle powertrains and E-Mobility. In both Europe and the USA, OME manufacturers support training and freely distribute technical information. Common concerns exist between the Europe, USA and Australian technicians with lack of basic electrical skills and knowledge.

Social and economic factors impacts

The existing cost of alternative fuel drive sources including electric and hybrid vehicles combinations has contributed to slow consumer uptake in the Australian market. Such vehicles in both Europe and the USA are intentionally priced to be competitive with other modern-day vehicles, with some overseas bodies encouraging consumers to take up these vehicle with money incentives. Government must push for alternative fuel drive sources including electric and hybrid vehicles combinations and should facilitate the adoption of these technologies. The impact of sustainability practices emerging in day to day society could also facilitate an increase to take up alternative fuel drive sources.

Environmental impacts

Sustainability and world environmental CO2 impacts will influence both vehicle manufacturers and consumers uptake of any new technology, with all vehicle manufacturers adopting alternative powertrain systems. Consumer perception of electric and hybrid combination type vehicles across the wide-ranging demographic point to a lack of acceptance of these type of vehicles, e.g. 'not trendy'. As consumer's cultural changes through the acknowledgement of global environmental impacts, all manufacturers vehicles are now looking at all alternative fuel drive sources including electric and hybrid vehicles combinations as a marketing option.

7. KNOWLEDGE TRANSFER: APPLYING THE OUTCOMES

Dissemination of the learnings of this program will be distributed through various Government, RTOs and Industry stakeholders.

Government:

The report will be distributed via email to government departments and accessable via internet access.

RTOs:

The report will also be distributed via email to RTOs automotive departments and accessable via internet access

Industry stakeholders:

The primary stakeholders interested in the dissemination of this research are the Automotive Alternative Fuels Registration Board (AAFRB Australia) and Auto Skills Australia Ltd (ASA). Both were strong supporters of this Fellowship. These organisations, with the support of the Victorian Automotive Forum, will drive the dissemination of the information gained from this study. The information discovered during this research will be presented in forums at these organisations, and at the Victorian Automotive Forum industry open days and at the circular reference group meetings.

The presentations will be supported by PowerPoint presentations with the option to subsequently forward the presentation to all participants by email.

These forums will be conducted at the following locations in 2015:

- VAF
- Chisholm Automotive department
- Industry and open days at Chisholm
- Circular reference group (CRG)
- Auto Skills Australia Ltd (ASA).

8. RECOMMENDATIONS

Following the research, the Fellow makes recommendations to government and industry stakeholders. These recommendations are:

- ASA and the AQTF to help establishment of an Australian recognised training program for technicians to meet all safety requirements to work on high voltage vehicle powertrains and E-Mobility vehicles
- The development of a two tear qualification, with the backing of professional associations such as VACC, IAME and the AAFRB thereby gaining a nationally accredited licence to be able to service and maintain high voltage vehicle powertrains and E-Mobility to both industry and workplace safety requirements
- Industry stakeholders such as Toyota, Honda, GM, Ford etc. to be invited to support the professional development of TAFE instructors and the development of learning resources. Industry would also provide access to high voltage vehicle powertrains and E-Mobility vehicle data to the automotive supplies and repair industry at an agreed amount
- The Fellow recommends the integration of high voltage vehicle powertrains and E-Mobility units into automotive apprenticeship training as core units and a review of workplace health and safety requirements in all units of competency relating to automotive high voltage vehicle powertrains / E-Mobility
- The Fellow recommends government and states bodies put in place more emphasis on using alternative automotive vehicle powertrains and E-Mobility in their fleet vehicle system thereby leading by example to encourage both public and fleet operations managers to up take new green automotive technologies and reduce greenhouse emissions and their carbon footprint
- The Fellow recommends government and states bodies put in place more emphasis on infrastructure to encourage the public to up take new green automotive technologies and reduce our carbon footprint by allocated money incentives.

9. REFERENCES

Automechanika Frankfurt 2014

http://automechanika.messefrankfurt.com/frankfurt/en/besucher/willkommen.html?nc

Koning Willem 1 College Netherlands

http://www.kw1c.nl/information-for-foreign-visitors

Lucas-Nulle

http://www.lucas-nuelle.com/305/apg/1425/Products/UniTrain-I.htm

Automotive Career Development Centre (ACDC)

http://www.fixhybrid.com/

Ninth Annual AltWheels Fleet Day

http://www.altwheels.org/fleetday.html

Worcester Technical High School

http://portal.techhigh.us/Pages/default.aspx

Big R/ReMaTecUSA USA, Automotive Parts Remanufacturers automotive remanufacturing event, USA, Las Vegas,

http://www.usitc.gov/

http://www.rematec.com/usa/Pages/Rematec-USA.aspx

AAPEX 2014

http://www.aapexshow.com/2014/public/enter.aspx

The SEMA Show - Las Vegas, NV

http://www.semashow.com/

Websites

http://en.wikipedia.org/wiki/Hybrid_vehicle_drivetrain

http://eex.gov.au/opportunity/use-alternative-drivetrain-technologies/

http://www.wocogroup.com/Innovative-drivetrain-technologies.240.0.html?&L=1

http://www.epa.gov/oms/technology/

https://www.dieselnet.com/tech/diesel_powerplants.php

http://en.wikipedia.org/wiki/Liquefied_natural_gas

http://en.wikipedia.org/wiki/Compressed_natural_gas

http://www.aafrb.com.au/

http://www.afdc.energy.gov/laws

http://www.worksafe.com.au/

10. APPENDICES

Appendix 1:

Automechanika (Frankfurt Germany) 2014 Exhibitor Statistics

Exhibitors, by Countries:	Total Year: 2014
International	3924
From Germany	707
Total:	4631
No of countries who attended:	71

Exhibitors, by product groups:	
Parts & Component's	2267
Repair & Maintenance	926
Electronics & Systems	532
Accessories & Tuning	521
Service Station & Car Wash equipment	291
IT & Management	94
Total:	4631

10. APPENDICES

Exhibitors, by Countries:							
Albania	1	Germany	707	Malta	1	Spain	125
Argentina	37	Great Britain	167	Mexico	14	Sweden	38
Australia	16	Greece	17	Moldavia	1	Switzerland	21
Austria	22	Hong Kong	78	Morocco	14	Taiwan	471
Belarus	1	Hungary	18	Netherlands	114	Thailand	43
Belgium	60	India	176	New Zealand	3	Tunisia	11
Bosnia-Herzegovina	2	Indonesia	15	Norway	7	Turkey	265
Brazil	34	Israel	12	Pakistan	19	Ukraine	4
Bulgaria	6	Iran	14	Philippines	1	United Arab Emirates	16
Canada	10	Ireland	4	Poland	145		
Chile	1	Italy	489	Portugal	15		
China	783	Japan	17	Romania	9		
Croatia	3	Korea	141	Russia	13		
Cyprus	2	Latvia	5	San Marino	2		
Czech Republic	30	Lebanon	2	Saudi Arabia	1		
Denmark	24	Liechtenstein	2	Serbia	8		
Egypt	12	Lithuania	8	Singapore	16		
Estonia	3	Luxemburg	3	Slovak Republic	13		
Finland	10	Macedonia	3	Slovenia	9		
France	113	Malaysia	25	South Africa	19		

Appendix 2

Massachusetts (USA 2014) Clean Cities Coalition Key statics:

Massachusetts (MA) Population: 6,692824 million people

Area: 8118mi² (21026km²)

- MA offers the Massachusetts rebate for Electric Vehicles program (MOR-EV)
- MA recently signed an 8 state MOU pledging to put 300,000 Zero Emission Vehicles on MA roads by 2025

MA has over 700 alternative refiling stations:

Biodiesel: 12,

Natural Gas: 24,

Ethanol (E85): 8,

Electric charge ports: 647,

Hydrogen: 1,

Propane (LPG): 20

Annual Greenhouse Gas Emissions Reduction: 16,985 tons (15408.5 metric tonnes)

Annual Gallons (Litres) of Gasoline (Petrol) Equivalent Reduction: 7,034,726 gallons (26,629,334 Litres)