

AUTOMOTIVE PAINT TECHNOLOGY INTO THE 21st CENTURY



Craig Kelly

International ISS Institute/DEEWR Trades Fellowship

Fellowship supported by the Department
of Education, Employment and Workplace
Relations, Australian Government

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Executive Summary

The introduction of water-based paint into the Australian Auto Refinishing Industry will provide significant benefits for the environment, manufacturers, the repair industry, and individuals working in the trade.

This International ISS Institute/DEEWR Trades Fellowship enabled the Fellow to access timely information and state-of-the-art skill sets on water-based application techniques and related issues.

Skill deficiencies addressed and new insights gained through the Fellowship experience included:

- State-of-the-art processes in water-based paint application
- Methodologies of colour matching of water-based paint by eye and spectrophotometer technology
- Robotic spraying techniques
- Water-based paint application in trade areas
- Comparative effectiveness of different spray guns used in the repair trade and manufacturing
- Identification of technical difficulties and trouble shooting solutions for water-based paint application
- Waste management techniques for manufacturing and refinishing
- Occupational health and safety (OH&S) issues relating to volatile organic compounds (VOC), including a study of the current European Union VOC regulatory regime

From evidence collected it is clear that the more quickly that Australia can introduce new VOC laws and implement water-based systems into vehicle repair workshops, the more quickly Australia will be able to contribute to cleaning up the environment.

The methods used in application of water-based paints are being introduced to the industry in Australia. Based on this, the Fellow's view is that it should be a very smooth and seamless process to introduce into the existing repair industry. With education and training the repairers should be able to see the advantages go far beyond just a cleaner environment.

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Abbreviations and Acronyms

µm	Micron
ANZSCO	Australian and New Zealand Standard Classification of Occupations
ANZSIC	Australian and New Zealand Standard Industrial Classification
EU	European Union
HS	High solids
HVLP	High volume low pressure
IAME	Institute of Automotive Mechanical Engineers
ICRIS	Intelligent Car Refinishing Information Service
kPa	Kilopascal (the metric equivalent to psi)
MPV	Multi purpose vehicle
MSDS	Material Safety Data Sheet
MTA	Motor Traders' Association
Pb	Lead
PPD	Paint Products Directive
psi	Pounds per square inch
RM	Rinshed-Mason Company
SED	Solvent Emissions Directive
SMART	Small medium area repair technique
VOC	Volatile organic compounds

Definitions

Bar A unit of pressure, 1 bar = 100 kPa

Skills Deficiency A skill deficiency is where a demand for labour has not been recognised and where accredited courses are not available through Australian higher education institutions. This demand is met where skills and knowledge are acquired on-the-job, gleaned from published material, or from working and/or study overseas.

There may be individuals or individual firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the IP to themselves; and over time they retire and pass way. Firms likewise come and go.

Reference: 'Directory of Opportunities. Specialised Courses with Italy. Part 1: Veneto Region', ISS Institute, 1991.

Sustainability The ISS Institute follows the United Nations NGO on Sustainability, "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Reference: http://www.unngosustainability.org/CSD_Definitions%20SD.htm

Acknowledgments

Craig Kelly would like to thank the following individuals and organisations who gave generously of their time and their expertise to assist, advise and guide him throughout the Fellowship program.

Awarding Body - International Specialised Skills Institute (ISS Institute)

We know that Australia's economic future is reliant upon high level skills and knowledge, underpinned by design and innovation.

The International Specialised Skills Institute Inc (ISS Institute) is an independent, national organisation, which has a record of nearly twenty years of working with Australian industry and commerce to gain best-in-the-world skills and experience in traditional and leading-edge technology, design, innovation and management. The Institute has worked extensively with Government and non-Government organisations, firms, industry bodies, professional associations and education and training institutions.

The Patron in Chief is Sir James Gobbo AC, CVO. The ISS Institute Board of Management is Chaired by Noel Waite AO. The Board comprises Franco Fiorentini, John Iacovangelo, Lady Primrose Potter AC and David Wittner.

Through its CEO, Carolynne Bourne AM, the ISS Institute identifies and researches skill deficiencies and then meets the deficiency needs through its *Overseas Skill Acquisition Plan (Fellowship Program)*, its education and training activities, professional development events and consultancy services.

Under the Overseas Skill Acquisition Plan (Fellowship Program) Australians travel overseas or international experts travel to Australia. Participants then pass on what they have learnt through reports, education and training activities such as workshops, conferences, lectures, forums, seminars and events, therein ensuring that for each Fellowship undertaken many benefit.

As an outcome of its work, ISS Institute has gained a deep understanding of the nature and scope of a number of issues. Four clearly defined economic forces have emerged out of our nearly twenty years of research. The drivers have arisen out of research that has been induced rather than deduced and innovative, practical solutions created - it is about thinking and working differently.

A Global Perspective. 'Skills Deficiencies' + 'Skills Shortages'

Skill deficiencies address future needs. Skill shortages replicate the past and are focused on immediate needs.

Skill deficiency is where a demand for labour has not been recognised and where accredited courses are not available through Australian higher education institutions. This demand is met where skills and knowledge are acquired on-the-job, gleaned from published material, or from working and/or study overseas. This is the focus of the work of ISS Institute.

There may be individuals or firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the IP to themselves; and over time they retire and pass way. Firms likewise come and go. If Australia is to create, build and sustain Industries, knowledge/skills/understandings must be accessible trans-generationally through nationally accredited courses and not be reliant on individuals.

Our international competitors have these capabilities as well as the education and training infrastructure to underpin them.

Addressing skill shortages, however, is merely delivering more of what we already know and can do to meet current market demands. Australia needs to address the **dual** challenge – skill deficiencies and skill shortages.

Acknowledgments

Identifying and closing skills deficiencies is vital to long-term economic prospects in order to sustain sectors that are at risk of disappearing, not being developed or leaving our shores to be taken up by our competitors. The only prudent option is to achieve a high skill, high value-added economy in order to build a significant future in the local and international marketplace.

The Trades

The ISS Institute views the trades as the backbone of our economy. Yet, they are often unseen and, in the main, have no direct voice as to issues which are in their domain of expertise. The trades are equal, but different to professions.

The ISS Institute has the way forward through its 'Master Artisan Framework for Excellence. A New Model for Skilling the Trades', December 2004. The Federal Government, DEEWR commissioned ISS Institute to write an Australian Master Artisan School, Feasibility Plan.

In 2006, ISS Institute Inc. set up a new ISS advisory body, the **Trades Advisory Council**. Members are Ivan Deveson AO; Martin Ferguson AM, MP, Federal Labor Member for Batman; Geoff Masters, CEO, Australian Council of Educational Research; Simon McKeon, Executive Chairman, Macquarie Bank, Melbourne Office; Richard Pratt, Chairman, Visy Industries and Julius Roe, National President Australian Manufacturing Workers' Union.

Think and Work in an Holistic Approach along the Supply Chain - Collaboration and Communication

Our experience has shown that most perceive that lack of skills is the principal factor related to quality and productivity. We believe that attitudes are often the constraint to turning ideas into product and a successful business; the ability to think laterally, to work and communicate across disciplines and industry sectors, to be able to take risks and think outside the familiar, to share – to turn competitors into partners.

Australia needs to change to thinking and working holistically along the entire Supply Chain; to collaborate and communicate across industries and occupations - designers with master artisans, trades men and women, Government agencies, manufacturers, engineers, farmers, retailers, suppliers to name a few in the Chain.

'Design' has to be seen as more than 'Art' discipline – it is a fundamental economic and business tool for the 21st Century

Design is crucial to the economic future of our nation. Australia needs to understand and learn the value of design, the benefits of good design and for it to become part of everyday language, decision making and choice.

Design is as important to the child exploring the possibilities of the world, as it is to the architect developing new concepts, and as it is to the electrician placing power points or the furniture designer working with a cabinet-maker and manufacturer. As such, design is vested in every member of our community and touches every aspect of our lives.

Our holistic approach takes us to working across occupations and industry sectors and building bridges along the way. The result has been highly effective in the creation of new business, the development of existing business and the return of lost skills and knowledge to our workforce, thus creating jobs - whereby individuals gain; industry and business gain; the Australian community gains economically, educationally and culturally.

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Fellowship Supporter

This Fellowship has been supported by the Department of Education, Employment and Workplace Relations (DEEWR), Australian Government.

The Australian Government's Department of Education, Employment and Workplace Relations (DEEWR) implements Government policies and programs to provide education and training opportunities for all Australians, to increase employment participation and to ensure fair and productive workplaces. Education, training and workforce participation are central to our goal of building a productive and socially inclusive nation, one which values diversity and provides opportunities for all Australians to build rewarding social and economic lives.

DEEWR are to be commended for their vision and commitment to on going trades training in Australia. Kelly would like to thank them for providing funding support for this Fellowship.

Supporters

- Albury Auto Paints Australia (DuPont, Spies Hecker, Standox)
Danny Bakes, Sales Representative
- Automotive Training Board
Deborah Joyce, Executive Officer
- BMW Australia
John Mailer, National Sales Manager
- De Beer Paints Australia
Richard R Reneman, General Manager
Pippa Taylor, Executive Assistant
- Ford Australia
Nova McNamara, Materials Specialist – Recycling & Sustainability, and '08 The Pratt Foundation/ISS Institute Overseas Fellow
- Hillis Ford/BMW Wagga Wagga
Terry Rooke, Assistant Manager
- Institute of Automotive Mechanical Engineers (IAME)
Chris Jones, NSW Operations Manager
- Mercedes-Benz, Melbourne
Nadine Young, Executive Assistant to the Managing Director
- Spies Hecker Australia
John Osbourne, Paint Representative
- TAFE NSW Riverina Institute
Rosemary Campbell, Director
Norman Madden, Relieving Head of Studies (Trades)
Graham O'Brien, Head of Department (Vehicle Trades)

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- Thomas Bros Toyota, Wagga Wagga
Steve Wait, Sales Manager
- 3M Sydney
Dave Lenertz, Sales Manager NSW
- Wagga Motors Pty Ltd
Tony Baillie, Assistant Manager
- Wagga Paint Distributors
Randall Brookes, Sales Representative

Organisations Impacted by the Vehicle Painting Industry

Government

- Commonwealth Government Departments and Statutory Authorities
- Department of Education, Employment and Workplace Relations
- Industry Skills Councils
 - Manufacturing Skills Australia (MSA)
- Department of Innovation, Industry, Science and Research
- Automotive Industry Innovation Council (AIIC)
- Commonwealth Scientific and Industrial Research Organization (CSIRO)
 - CSIRO Materials Science and Engineering Division
 - The Australian Paint Approval Scheme (APAS)
- Department of the Environment, Water, Heritage and the Arts
 - Environment Protection and Heritage Council (EPHC)
- State and Territory Government Departments responsible for environment, sustainability, innovation and industry
- Commonwealth, State and Territory Environmental Protection Authorities (EPA)
- Commonwealth and State Workcover authorities
- Local Government Councils and Shires

Education

- Vehicle Trades/Vehicle Painting, Riverina TAFE Institute
- The Competitive Manufacturing Centre, Kangan Batman Institute of TAFE
- The National Centre for Sustainability, Swinburne University (TAFE)
- University departments and faculties of industrial and product design and engineering

Automotive Manufacturers

- Ford
- GM Holden Ltd
- Toyota

Acknowledgments

Professional Associations

- Motor Traders' Association
- Motor Vehicle Repair Industry Council
- Automotive Training Board
- Institute of Automotive Mechanical Engineers (IAME)
- Federation of Automotive Products Manufacturers (FAPM)
- Australian Life Cycle Assessment Society (ALCAS)

Industry

- Automotive component part manufacturers
- Co-operative Research Centre for Advanced Automotive Technology (AutoCRC)

About The Fellow

Name: Craig David Kelly

Employment: Vehicle Painting Teacher, TAFE NSW, Riverina Institute

Qualifications

- Trade Certificate in Vehicle Painting, Newcastle Technical College, 1973
- Indenture of Apprenticeship, Trade of Coach Painting, 1974
- Diploma Teaching in Technical Education, University of Technology Sydney (UTS), 1992

Memberships

- Institute of Automotive Mechanical Engineers (IAME)

After a number of years in the commercial panel repair sector, the Fellow commenced his full time teaching career at Wagga TAFE in 1984.

During his teaching career, Kelly has undertaken a number of administrative roles, including Acting Head Teacher and Acting Senior Head Teacher. Through his desire to maintain direct contact with students the Fellow has eschewed any ambition of to take on higher management and administrative positions on a permanent basis.

At present Kelly trains Australian Defence Force (ADF) personnel in corrosion control, particularly relating to helicopters.

As well as teaching trade courses, the Fellow teaches airbrush work to TAFE-delivered education and training for school students.

Aims of the Fellowship Program

The purpose of the Fellowship program was to study the following:

- State-of-the-art processes in water-based paint application
- Colour matching of water-based paint by eye and spectrophotometer technology
- Robotic spraying
- Water-based paint application in trade areas
- Comparative effectiveness of different spray guns used in the repair trade and manufacturing
- Identification and trouble shooting solutions for water-based paints application
- Latest waste management techniques in manufacturing and refinishing
- Occupational health and safety (OH&S) issues relating to volatile organic compounds (VOC), including a study of the current European Union VOC regulatory regime.

Identifying the Skills Deficiencies

Numerous European car manufacturers have moved towards the use of water-based automotive paints. These include BMW, Mercedes-Benz, and Volkswagen. Australia is in the process of adopting this technology and having it fully implemented within five years.

It is important that Australia's tradespeople are fully trained so that they are able to work with this new technology with the minimum amount of disruption, and without risking quality of workmanship and financial loss, while still observing occupational health and safety requirements.

Specific skill deficiencies addressed through the Fellowship were as follows.

1. Current international best practice waste management and maintenance procedures

- Techniques for the removal of water-based paint from filters in spray booths
- Latest methods for cleaning spray equipment
- Colour spray waste disposal
- Filter maintenance and replacement protocols in respirators and spray booths
- New safety equipment and technologies
- Storage, disposal and recycling of waste products

2. Identification of improved environmental outcomes from introducing water-based systems

- Knowledge of EU regulations relating to automotive paints and the applicability of these regulations to Australia

3. Latest techniques used to match water-based colour by eye matching

- Identification of problems associated with metamerism, fugitive colour and water-based paint, as well as solutions to such problems.
- Update knowledge on the range and characteristics of metallic tints. Investigate mass tone techniques in metallics, solid colours and pearls and the use of clear over the colour for the final colour match

4. New techniques and technologies in use to match water-based colour by using a spectrophotometer

- Assess latest available spectrophotometer machine technology with particular emphasis on improvements in standardisation and calibration

5. Obtain relevant skills in surface preparation for the application of water-based paints

- Best practice techniques for painting over polyester finishes

6. Develop new skills in the application of water-based automotive paint

- Through direct working experience in factory environments, compare and assess the advantages and disadvantages of automated application techniques during manufacturing (robots, bells discs and gang sprays) to manual techniques
- Learn the latest techniques used for paint application (eg number of coats required in a manufacturing environment compared to in the repair industry).

Identifying the Skills Deficiencies

7. Obtain new skill sets in determining suitable drying processes in both manufacturing and the repair industry

- Identify and differentiate different drying processes used with water-based paints in the manufacturing environment compared to the repair industry
- Obtain new insights in choosing the most appropriate drying method when working with water-based paints

8. Develop a sufficient skill level to complete off the gun a factory quality finish up to prestige show finish

- Understand the differences in the internal components of a spray gun, compared to conventional guns using solvent-based paint
- Identify differences in air pressure required to apply water-based paints

9. Paint technology of water-based paints

- Better understand the range, chemical characteristics and OH&S issues relating to current paints
- Better understand component colours that combine to make the final colour and the related proportions
- Obtain new skills for mixing water-based paints

The Australian Context

Australia does not have a history of paint technology innovation related to the automotive industry. Major innovations from Europe and the USA have been adopted by the domestic industry.

In the early part of the 20th century automotive paint technology was based on the same air-dry varnish systems that were used for wooden furniture and horse drawn carriages. The major drawback of this system was that it was only available in black and took days of drying between coats applied with a brush.

In 1923, E. I. du Pont de Nemours and Company developed nitrocellulose lacquer systems which offered multiple choices of colours and easier application using spray guns. These new lacquers, however, had very poor resistance to chemicals and fuel spillage. Nitrocellulose lacquers were used on some passenger cars through to the late 1950s, when solution acrylic lacquers were introduced. Acrylic lacquers offered improved durability and more colour ranges, including metallic colours.

Between the 1930s and the 1960s enamel paints were developed to commercial use stage. These products required baking in order to cure the paint.

The breakthrough technology of acrylic lacquer achieved in the 1960s was complemented with the introduction of the 'two pack' paint application system in the following decade. Although initially cost-prohibitive, advances in the technology of 'two pack' materials and processing reduced costs steadily throughout the 1970s and into the 1980s to the point where today most cars are painted via the 'two pack' system.

This technology has been a boon for the durability of automotive paint, but the addition of isocyanate to deliver extended paint life has made the application of this paint very dangerous to the user.

At the time of the development of this new spray painting system the general work wear for a spray painter was thongs, shorts and a singlet. Spray painting was done in the open air. Spray booths were not used.

Despite the lead content of paint being reduced to 24 per cent in the mid 1970s, the concept and practice of occupational health and safety, in the main, did not exist in the Australian spray painting workshop at that time. Focus was more on the quality of the paint job with little or no concern for employee health.

Waste management methods have been various.¹

To dispose of waste thinners many paint and panel shops simply poured down the drain, or poured on used thinners over waste rags that were then disposed of in an incinerator. This was not only hazardous for the person disposing the waste rags into an incinerator (explosion hazard), but also detrimental to the local and wider community because of the toxic fumes being pushed into the atmosphere. Paint thinners were also soaked into the soil when poured around fence lines to kill weeds and long grass.²

¹ Garry Edwards, '01 ISS Institute/TAFE Fellow, and Manager, Centre for Competitive Operations (CCO), Kangan Batman TAFE, traveled to Italy, England, Holland and France to research best practice strategies in environmental waste management and supporting education and training programs for employers and employees within the Collision Repair Industry. The Fellowship was sponsored by ETTE, Victorian Government. Contact ISS Institute for a copy of his report, 'Waste Management in the Automotive Collision Repair Industry'.

² This occurred in each workshop Kelly was employed in during the 70s

The Australian Context

With the introduction of the 'two pack' it was very difficult to persuade employers and employees of the health risks associated with the absorption of toxic chemicals through the skin, eyes and mouth. In Australia, it was a very slow process to educate the industry of the health risks associated with the application of 'two pack' paint. There was also the problem with wet sanding as some workshops would rub down using a hose. In this instance, the paint being removed was most likely to go out of the shop into storm water drains. Due to the toxicity of the paint, the spray painting industry is categorised as a dangerous trade.

As observed by the Minerals Council of Australia: *"Spray painting with 2-pack paints produces the highest exposures and has been reported as the main cause of occupational asthma in the United Kingdom."*³ Workplace Health and Safety Queensland also note that isocyanates will *"cause occupational asthma in a significant percentage of exposed people."*⁴

Short term health dangers such as nausea, skin irritation and rashes, and long term illnesses such as occupational asthma, lung cancer and sensitisation (becoming allergic to the paint), are just a few of the problems that can occur if a painter is not properly protected.⁵

The 1980s saw a number of positive developments in terms of OH&S and productivity. The industry began using positive pressure downdraught booths with water floors and air filters through the roof and vents in the floor. This allowed fresh air to flow across the painter's face with waste drawn downwards into the water and away from the painter. Material Safety Data Sheets (MSDS) became standard issue to spray painters.

The industry now uses air fed respirators, overalls, disposable paper overalls, nitrile gloves (solvent proof), goggles, boots, dry sanding techniques using palm sanders and high powered vacuums, and compulsory use of spray booths.

Infrared technology was also introduced to speed up the drying of panels. This in turn freed up spray booths for larger jobs. The industry also moved from volume scales to satarious weight electronic scales. This helped with greater accuracy in colour making off the machine and cut down on colour matching times.

Waste management, however, is still an issue with water-based paint systems. Water-borne products contain substances that endanger the environment and waterways. The disposal of residues and waste, therefore, is still governed by the same guidelines and regulations that apply to conventional solvent-based paint.

Water-borne material still needs to be disposed correctly through licensed waste disposal companies.

Early efforts in colour matching was difficult as the process involved spraying with two different paints. Acrylic lacquer application required seven coats of colour and baked enamel only required three. When spraying metallic acrylic lacquer the aluminium flake in the metallic would sit differently on each coat and made it almost impossible to colour match. From one tin of colour up to 32 different colours using different spray techniques could be obtained without the addition of tinters.

³ http://www.minerals.org.au/__data/assets/pdf_file/0012/26013/safety_bulletin74.pdf

⁴ Ibid

⁵ http://www.workcover.nsw.gov.au/Documents/Publications/AlertsGuidesHazards/General/spray_painting_what_apprentices_need_to_know_0416.pdf

The Australian Context

Today the Australian industry standard involves spraying solvent-based paint over the top of water-based paint. Consequently, colour matching is a completely new skill for those working in this occupation.

By the end of 2009 it is expected that there will be no lead in any automotive paint. The trend for use of water-based systems has already commenced in Europe and in the United States and is finally making its way into Australia.

Governments worldwide are imposing ever stricter emissions standards. There will be a requirement to use fully de-ionized water instead of solvent-based paint.

Even with the introduction of the new water-based spray paint technologies into Australia, there are still a number of challenges. Water is not as good a carrying agent for pigments. Shine and 'depth' is not as attractive as solvents based paints. Paint manufacturers have been working long and hard to overcome the difficulties of water-based paints. Within a few generation cycles great improvements have been made and more is expected in the near future.

It is important that the Australian spray painting industry develops and maintains links with all offshore paint companies and research institutions so that staff can be upgraded and trained in both theory and practical aspects of new technologies and techniques.

The use of water-based paints is in its infancy in Australia. European cars imported into Australia however, are currently painted in water-based paint. Toyota is also being painted in water-based paint.

The Australian Government has announced a five-year timeframe for the Australian spray paint industry to become fully water-based. Europe is already two years ahead of Australia and will move further ahead with environmentally friendly spray paint methods.

It is imperative that greater efforts are made to speed up the introduction of water-based paint technologies across Australia.

SWOT Analysis

A SWOT analysis provides a useful avenue for exploring water-based paint technologies and application techniques as well identifying opportunities for future developments.

Strengths

- Environmental benefits
- Develop strategies to deal with new waste management laws
- Develop knowledge on problem solving using water-based paint
- Occupational health and safety benefits gained by the introduction of water-based paints into the industry
- Develop extensive knowledge of water-based paint
- Training country, regional apprentices and tradespeople
- Train trainers/teachers
- Help regional paint distributors with information and advice
- Understand volatile organic compound laws

The Australian Context

- Gain knowledge on new spray gun technology
- Economic benefits
- Full understanding of the new drying processes
- TAFE will receive a water-based system on completion of Kelly's training to commence use in Riverina TAFE in 2009
- Learn how to successfully colour match water-based paint in the refinish trade over manufacturer painted finishes

Weaknesses

- Cost of a new paint system
- All apprentices and tradespeople will require training in the application of water-based paint
- New drying systems will need to be purchased and installed
- Attitude towards change – some users are very reluctant to move from a field in which they are very comfortable, to a new area
- Support from paint companies may not be adequate
- Colour matching using the eye and spectrophotometer will require training
- Spectrophotometer is an expensive piece of equipment
- New spray guns will be required to apply water-based paint and will be an expense for the repairer
- Insurance companies will need to develop new quoting procedures depending on what type of paint is required
- Painting older cars that have been painted with solvent based paint, may prove to be a challenge, as well as colour matching the two types of paint
- Availability of clean up equipment for spray guns

Opportunities

- Training new users
- New training packages/syllabus for the industry
- More durable paint finishes
- Short courses for tradespeople to bridge knowledge gaps
- New training opportunities for ADF personnel
- Improved environmental health
- Improved health and safety conditions for workers
- Better environmental outcomes
- Further development of paint technology

Threats

- Small operators having increased expenses setting up workshops to meet new environmental legislation
- Training package development may not be timely. It may not be ready when workers are requiring the training

The International Experience

1. Lelystad, Netherlands
2. Stuttgart, Germany
3. Munich, Germany
4. Cologne, Germany
5. Midlands, UK



The Netherlands: De Beer Refinish Holland

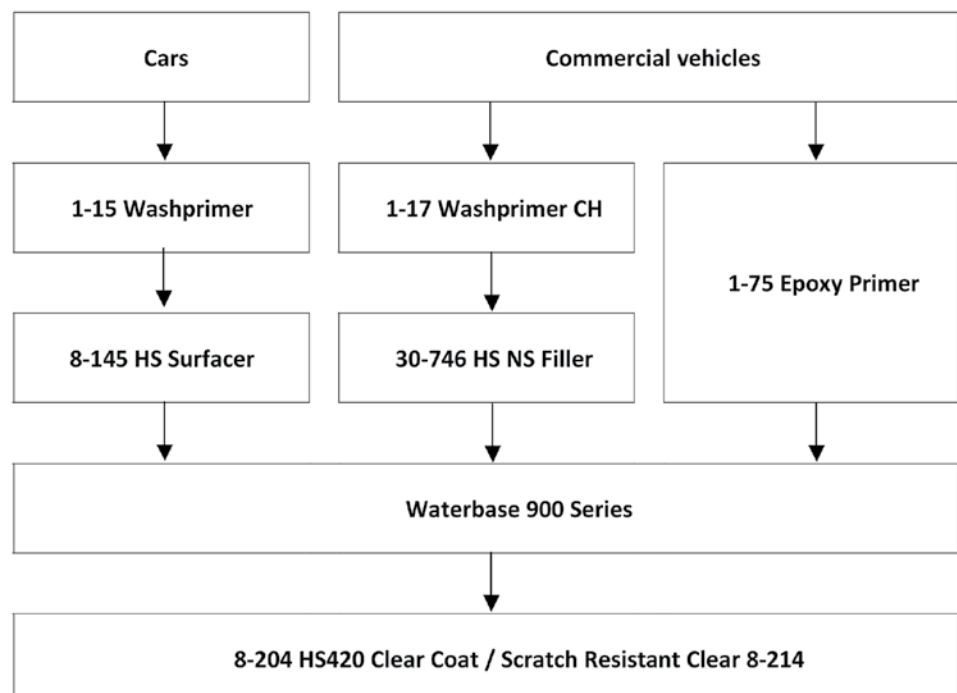
Lelystad, The Netherlands

De Beer Holland – Waterbase Training Course

- Waterbase 900 series – technology and development
- Mixing colours – pigment and mixing theory/practical and colour adjustment techniques
- New technology – Spectrophotometer theory and practical
- Application – blending techniques and practical
- Factory tour of De Beer premises

De Beer Waterbase 900 Series

This series of paint is compliant with current EU VOC legislation.



The International Experience

Outline of the EU VOC legislation

Directive 2004/42/EC on the content of VOCs in coatings products aims to harmonise national laws and provisions with regard to combating ground-level ozone by establishing limit values for the content of VOCs in coatings products. This will prevent the restriction of free movement of these products within the European Union and reduce ground level ozone formation.

The Directive places limits on the VOC concentration of coatings for paints and varnishes in two phases. Phase I has been active since 1st January 2007 and Phase II will be active from 1st January 2010. The limits for VOCs in coatings are lower in Phase II than in Phase I. The Directive is applicable to both water-based and solvent-based coatings. The coatings for which limitations have been determined are listed in full in the Directive and are shown in the table below.

Maximum VOC Content Limit Values for Vehicle Refinishing Products

Product Subcategory	Coatings	VOC g/l (1.1.2007)
Preparatory and cleaning	Preparatory	850
	Pre-cleaner	200
Body filler/stopper	All types	250
Primer	Primer Surfacer/filler and general (metal) primer	540
	Wash primer	780
Topcoat (each layer)	All types (Base coats, direct gloss, clear coats, 3-stage topcoats)	420
Special finishes	All types (Aerosols, scratch resistant clears, interior finishes)	840

Primers are solvent based but still comply with current European VOC legislation.⁶

Primers available:

- Wash primer
- Epoxy primers
- High Solid Surfacers
- Non Sanding filler

Equipment and Application Conditions

Spray Booths

De Beer recommends positive pressure down-draft spray booths for the application of water-based paint. For example the one in Lelystad was gas heated, slight overpressure, adjustable temperature (up to at least 60° Celsius), minimum air movement of 20.000m³ per hour, and a minimum air speed of 20cm/sec.

⁶ http://ec.europa.eu/environment/air/pollutants/paints_directive.htm (the VOC Solvents Emissions Directive)

The International Experience

Air Quality

One of the biggest hurdles faced by painters of water-based paint is silicone and oil. Air needs to be totally free of these. To help keep air quality at an optimum level air filtering is far more important than in the past. Activated charcoal eliminates both oil and silicone.

Spray Guns

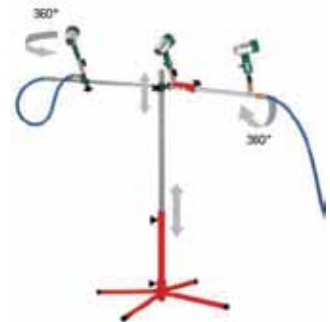
De Beer recommends DeVilbiss and SATA gravity feed spray guns for spraying water-based paint as these are the most commonly used guns in Europe. They have been developed and tested with the use of water-based paint in mind. These guns are used for both painting and blending. One is to use a spray gun that is only used for water-based base coats and no other products. HVLP spray guns give a better result than the conventional spray gun (less air entrapment). It also saves material.

Blow-Drying Equipment

Blow-drying equipment is a must as the paint will not dry without good air movement. There are different types available. The dryers mounted on the drying frame are detachable units that can be used by hand.

Mobile Units

SATA	Dry jet
Trisk	Hydromate
EMT	Venturi system
DeVilbiss	Aerodry system
De Beer	Dedoes

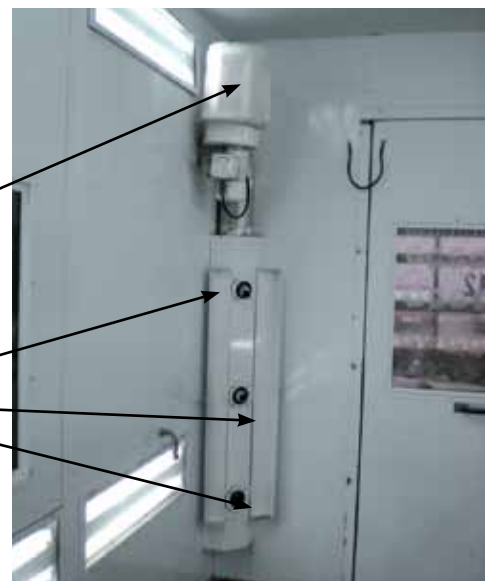


Stationary Units

Rowit
Jun-Air
EMT

Air filter

Stationary drying unit in spray booth at De Beer, Lelystad
(one in each corner of booth)



Stationary drying unit

The International Experience



Heating

Heating

Heating can be convection (most common) or infrared. There are robotised infrared systems available. With the robotic drying systems the drying time is reduced by 40 per cent. For example primers: 2.30 minutes; wet on wet undercoat: 2.00 minutes; water-based colour: 1.30 minutes; and clear lacquer: 4.00 minutes.

Symach has a range of infrared, in-booth robotic dryers. The Easydry is semi automatic, which means that once it has been programmed it passes over the car to fully dry it. A full car can be completed in eight minutes.

Sanding

- Sanding can be done dry, or wet and dry.
- Finishing off dry (P360-P500) using a three orbit sanding machine. This will ensure there are no sanding marks left in the primer to come through in the top coat clear.
- Finishing off using wet and dry P800-P1000, for hand sanding using clean water.

Degreasing

When using silicone remover always use two clean cloths. Spray the product onto the job using an atomizer (this will save on volume of product used) then wipe with one cloth and finish with a dry cloth. This stage is especially important when preparing for water-based application as it is very important that there is no oil or silicone residue on the panel to be painted.

Non-Paint Products

- Masking paper, or plastic of high enough quality to ensure that the water-based paint will not penetrate.
- Water resistant crepe back masking tape (always use the right waterproof masking paper and tape).
- A tack rag, suitable for water-based products to clean the object and make it dust free.
- Plastic mixing cups (not tins, which are commonly used in Australia with solvent based paint).
- Plastic stirring sticks, not aluminium.
- Paint strainers – should be water resistant and have a minimal mesh size of 125 microns.

Paint Storage

The storage life of De Beer 900 series paint is 18 months to two years. As the paint must not be stored below 5° Celsius, a temperature controlled paint cabinet is required. The pot life is six months for mixed colours.

You can tip a water-based paint container upside down and no paint comes out. When you push the bottom of the container with your thumbs the paint runs out. The base of the container slides up towards the top pushing the paint out.

This method has been created to remove the air from the paint container that usually occurs after paint has been removed, which is called ullage. This will increase the shelf life of the product.



Paint storage

The International Experience

Colour Formulation

De Beer uses the ICRIS system for formulating colours. It is a computer system that shows the user vast amounts of information about the colour that they are about to use. It includes the VOC (g/l) level of that colour.

Water-Based Degreasing Agent

This product is applied with two clean cloths. Spray the product onto the job, wipe it with one cloth, then wipe off with a clean cloth. Tack rag the job. This is a totally different product to the degreasing on the previous page. Both steps must be followed – the degreasing and the water-based degreasing agent. The degreaser removes silicone and this product removes sweat and static electricity.

Thinning

De beer recommends the following mixing ration for own-made formula: add 10 per cent thinner 9-151. Neither tap, nor distilled, nor bottled water is recommended. The special water required is de-mineralised, de-ionised and contains anti-bacterial additives.

Water-Based 900 Series Colour

This product is VOC compliant and very easy to use. The techniques that follow allow for a good finish on the paint job. Some of the techniques are being introduced into Australia with solvent-based paint and this will allow for a smooth transition to the water-based systems that will soon become available.

- *Step 1* – Apply a dust or mist coat at 2 bar. This is a control layer to check that there is no silicone, sweat, and oils left on the substrate.
 - Repair measures are still possible at this stage.
 - Blow dry with a hand held dryer.

- *Step 2* – When step one is dry, apply two wet on wet coats at 2 bar to make sure it is covered. There is a 'blue' effect, which will evaporate out when the paint is dried. The correct colour of the finished product cannot be seen until the water has evaporated.

Blow dry with a hand held dryer for small panels, or if for a full re-spray use a stationary unit with a temperature between 30-35° Celsius.

Dry to a matt type finish, check the coverage and re-apply if necessary. This is best done with a hand held 'daylight' as coverage can be difficult to determine under artificial light. Re-apply more colour coats if necessary.

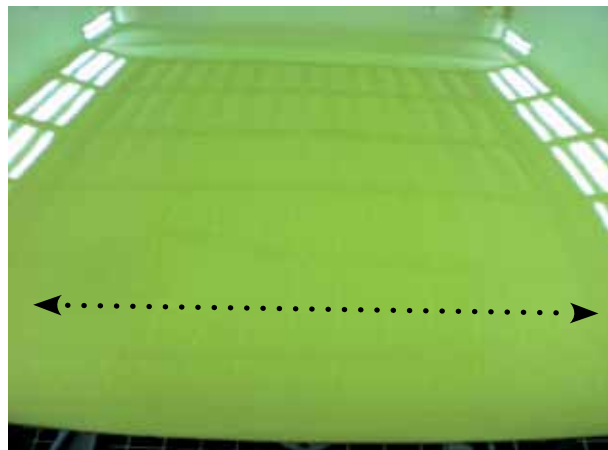
- *Step 3* – Drop coat at 1 bar.
 - Distance of spray gun from the panel should be between 50 and 60cm.
 - Do not apply too wet. Blow dry the object.

A drop coat is a light coat, sometimes called a mist coat or tack coat. The spray gun pressure is reduced and the gun is held further from the surface. The paint needs to form wet droplets to make sure you gain adhesion for good finish of subsequent clear coats. Drop coats are generally recommended to reduce mottling and blotching, and allow for blending of original to new colour sections.

The International Experience



50-60cm distance for drop coat application



Drop coat versus no drop coat. Centre section has no drop coat.

The panel above right has had the centre section masked up to compare the paint finish with a drop coat and without. A much better finish, with a better depth of colour is achieved with a drop coat.

Cleaning the Spray Gun

Use an appropriate gun cleaner for cleaning water-based guns. They are environmentally friendly and provide minimum cleaning agent consumption.



Flushing and cleaning the paint channel and air cap, approximately 21 seconds.



Dry blowing; used cleaning liquid is collected. Approximately four seconds.



Clean after two steps.

Do not use thinners (acrylic based or 'two pack' based thinner) – only use a water-based gun cleaner.

Apply Clear Coat

Clear is still solvent-based and is applied exactly the same way as for old solvent systems with De Beer products. High solid scratch resistant clears are being used for protection of the water-based colour in some workshops. Water-based clears are being used in some areas in Europe, but they have a very milky effect and paint companies are researching techniques for improving the finished product.

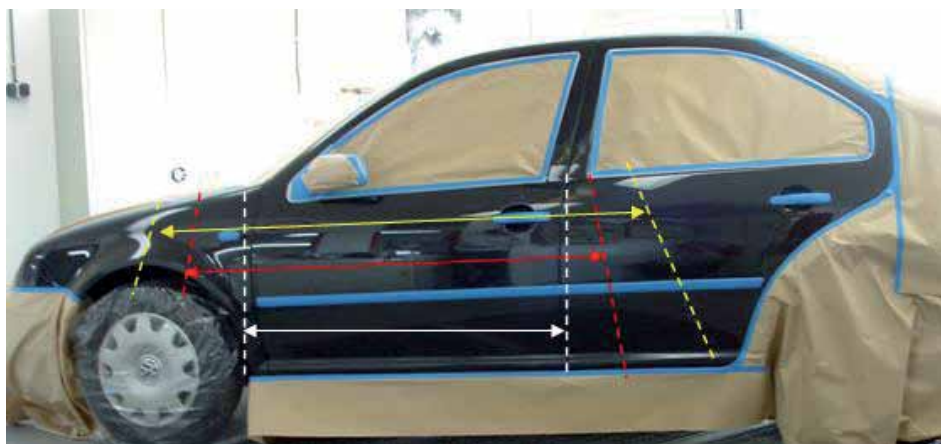
The International Experience

Blending

Preparation – If the vehicle has been painted that day, it only needs to be hand rubbed with G3 Ferecla. If it is the second day, it needs to be sanded, either dry or with wet and dry abrasive in a slightly larger area than the damaged area.

Clean with a water-based degreasing agent then tack off the entire area.

- *Step 1* – Spray pressure at 2 bar
- *Step 2* – One mist coat
- *Step 3* – Blow dry, then tack off
- *Step 4* – Two coats of colour to cover
- *Step 5* - Blow dry, then tack off
- *Step 6* – Drop coat at 1 bar
- *Step 7* - Blow dry, then tack off
- *Step 8* – Apply clear coat



Blending (white dotted lines indicate the first coat, red dotted lines indicate second coat, and yellow dotted lines indicate drop coat)

The WaterBase 900 Series is one of the most user-friendly water-based coating systems currently available. One of the improvements of the WaterBase 900 Series is that it is an entirely non-stirring system.

Colour Matching

Water-based paint colour matching is similar to solvent-based paints, except that spray out cards **MUST** be used. One must apply two coats of colour followed a drop coat. Once dried, a clear coat is applied (sometimes twice) as the final coat. Then compare to original paint finish on the car.

The main difference with the colour matching process, is that the colour matching is not the only adjustment necessary. It is the expertise of the painter being put to the test, to apply a good drop coat and being able to adjust the spray gun pressure so that a good blend into the original colour is possible, even if the colour match is not perfect.

The International Experience



A spectrophotometer measures colour and generates numerical data for analysis.

Spectrophotometer⁷

The spectrophotometer is used extensively in European and UK paint workshops for colour matching due to the winter weather conditions providing very low light conditions for most of the time. It speeds up the colour matching process, by eliminating much of the trial and error, which in some cases can take years for the painter to learn.

Modern automotive paints, with their metallic formulations that appear to change colour at different viewing angles, present a unique colour quality control challenge.

Automotive manufacturers have established stringent colour matching standards for virtually every coloured component in the vehicle. Making certain that these new paint formulations will meet the automotive manufacturers' colour standards requires advanced quality control techniques.

Germany: SATA GmbH & Co. KG

Domertalstrasse 20, 70806 Kornwestheim, Germany



SATA Product Training

- Welcome and plant tour
- Presentation of most current SATA product range for car refinishing, including air purification and breathing masks
- Practical demonstration of SATA car refinish spray equipment
- Practical painting activities

Presenters – Marzin Mashalla, Technical Expert, and Michael Backhaus, Asia Pacific Export Manager.

SATA was established in 1907 with the foundation of Sanitaria, manufacturing medical instruments. Today they are world leader in spray gun technology.

- Export share: over 70 per cent
- Quality Assurance System: ISO 9001⁸

Plant Tour

SATA has been at its current premises in Kornwestheim near Stuttgart, since 1990. This is their only manufacturing site in the world. The central office, training centre (Technikum), design, manufacturing and assembly, shipping and orders, export, are all at this address. It is a family owned business since its inception in 1907.

In the foyer of the training room the company has three virtual painting trainers, where one can spray onto a virtual screen and at the end of the job it will give a score for technique and coverage.



⁷ Definition: 'an instrument used for measuring the transmission or reflection of light by comparing various wavelengths of the light' <http://www.yourdictionary.com/spectrophotometer>

⁸ <http://www.sata.com/index.php?id=3953&L=1>

The International Experience

SATA Products

Filtration Systems

Clean, compressed air is essential for use with water-based paint. Oil or oil vapour, even in minute amounts, are an almost certain 'cause of defect' with good quality paint jobs. In most cases, they cause silicone-like craters, re-work or complaints. Then cost intensive re-work has to be done. This not only applies to solvent-based paints, but especially for water-based paint materials. A good filtration system is essential. SATA produces these products to complement their spray guns.



SATA worker health protection system – safety for optimum health protection



Activated charcoal filter – modular system of air filtration

Legend for above image

A) ① SATA filter unit ③ Activated charcoal absorber B) ① SATA filter unit ③ Belt with air regulator
C) ① SATA filter unit ③ Industrial belt unit A), B), and C) ② Compressed air feeder hose, crush and kink resistant ④ SATA air warmer ⑤ Air hose ⑥ SATA top air breathing air humidifier ⑦ Breathing hose connection ⑧ SATA respirator hood ⑨ Shoulder strap

Disposable Cup Systems

'SATA RPS' is SATA's own disposable cup system. This diagram shows the pot, lid and strainer which are built to work with SATA's own spray guns.

Mixing is done directly into the cup (all the measurements are clearly labelled on the side of the cup). No additional mixing containers are required. Easy to read scales and all common mixing ratios are printed on the cup.

The cup is sealed hermetically for storage and re-use of remaining paint, preventing solvent or water diffusion, which may affect the colour shade. Furthermore, the sturdy cup makes handling easier.



SATA's disposable cup system

The International Experience

The cups can be stacked after use, so that they consume less space, and can be simply disposed. This saves work time and cleaning agent and no special waste disposal system is required.

Spray Gun - Manufacturing Process



Step 1



Step 2



Step 3



Step 4

The International Experience



Step 5



Step 6



Step 7



Step 8

Steps 1-8, SATA® 3000™ HVLP 1.3 digital manufacturing process. SATA's excellent reputation as a spray gun manufacturer is founded on state-of-the-art precision production processes. Strict, precise quality control during manufacturing and assembly ensure a permanently high level in spray performance and atomisation

SATA spray guns comply with VOC regulations for solvent emissions to protect the environment. They have a transfer efficiency rate of 65 per cent and more

The International Experience

All SATA spray guns are completely chrome plated for optimum corrosion protection. Corrosion-resistant material passages made of stainless steel. The material nozzle and paint needle are made of stainless steel and have a nickel plated brass air cap.

Spray Gun Turbo Cleaner

This gun cleaner mounts easily in a preparation room and is suitable for solvent or water-based paint systems. The high acceptance of disposable flow cups has considerably eased work processes in the spray booth. This cleaner ensures quick, proper and comfortable cleaning of the spray gun. It has a very high cleaning power and residue free removal of all paint remainders in the paint channel, even in difficult to access places. It optimises the painters work processes and, therefore, body shop profitability. This is only one of SATA's range of gun cleaners that they have available.



Safety Equipment

Safety of the painter is more important than ever with water-based paints. The ideal system for active health protection, wearer comfort and optimum hygiene, protects the respiratory system, eyes, skin and hair from harmful particles (especially important with water-based paints).

There are many different safety options available. When spraying water-based paint an air-fed hood is a must for total protection. Water-based paint is a significant benefit to the environment, but user safety is still of utmost importance and there is still the need for complete protection. Human skin is permeable to many substances. To minimise absorption, full protection is required.



Painter with disposable gloves, glasses, respirator and overalls



Safety equipment



Air fed hood

The International Experience

Demonstration of SATA Car Refinish Spray Equipment

- *Step 1* – Select the correct gun for the type of application: water-based primer, solvent based primer, water-based colour, water-based clear, or solvent-based clear.
- *Step 2* – It is important to select the correct gun with the correct set up for chosen application process. The correct air pressure is essential for a good paint job. Apply in an appropriate spray booth.
- *Step 3* – Water-based clear coat application. The whole panel in the photo below has been sprayed with a water-based clear coat and has turned clear. On the left of this panel excess paint has been applied to demonstrate how the clear looks on application. It has a cloudy, milky appearance and then turns clear as the water evaporates.
- *Step 4* – Below is the same panel after the cloudy appearance has disappeared. The run is still apparent on the lower section of the panel, where it skinned over and kept air trapped in a very thick section of the paint. The excess application on the top section of the panel is almost invisible after drying.



Step 1 – select the correct gun



Step 2 – application of water-based primer at SATA training centre



Step 3 – milky appearance of water-based clear coat



Step 4 – water-based clear coat after drying

The International Experience

Germany: Ford-Werke GmbH

Koeln-Niehl, Henry-Ford Strasse 1, D-50735 Koeln, Germany



Paint department at the Ford plant, Cologne

Ford Plant Visit

- Welcome and tour of paint shop 1 (pre treatment, sealer and primer)
- Visit paint shop 2 (enamel, buy off, wax, paint sludge, etc.)
- Meeting and discussion with Markus Diener, Vehicle Operations Manager, European Paint Engineering; Rolf Karge (paint process), Carsten Herse, Supervisor, Environmental Quality Office, Europe; Bernd Schmitz (Safety Officer), Andre Thierig, Resident Engineer, European Paint Engineering, Paint Shop Cologne

Ford Cologne has been painting with water-based paint on the production line for ten years. During recent times Ford has had a major reorganisation of production, with one billion Euros being invested in the upgrading of their major European plants. The Cologne plant is located on the Rhine River for easy access to transport and has the reputation of being one of the most efficient car manufacturing plants in Europe. It also has the honour of being the first Ford assembly facility in the world to build the new Fiesta.

Early in 2008, Ford began sourcing renewable electricity to cover the *full* electric power demand of its Fiesta manufacturing and engineering facilities in Cologne. Through this initiative, the company will reduce its CO₂ emissions by 190,000 tonnes per year. This initiative is part of the company's overall commitment to further reduce the environmental footprint of its vehicles through their entire life cycle.

The International Experience

The Paint Production Line

Paint Shop 1



Pre-treatment entry. This is the beginning of the paint production line. Prior to this stage the car is checked for dents, scratches and marks. Anything found is rectified before entering the pre-treatment area.



Pre-treatment auto-unload (wet body before oven)



After electro-coat oven

The International Experience



Sealer automation



Primed body

Paint Shop 2



Primer sanding/enamel preparation. There is abundant florescent lighting so that faults can be easily detected.



Water-base, base coat robots. The spray pattern is easily seen in this photograph and is much larger than a repairers spray gun. Therefore the number of strokes to paint the panel is far fewer.



Enamel clear coat robots for door shuts. The robots sleep until the car breaks the infra red beam and then they start application. This saves energy.



Enamel Clear coat applied by an ESTA machine (robot)

The International Experience



Buy off – final quality line



Wax automation



Final quality check

Factory Coating Details

Phosphate and electrocoat are dip applications.

- Coating weight: 1,3 4,5 g/m²
- Film thickness electro-coat: minimum 16µm (underbody minimum 23µm)

Primer is an electrostatic spray application.

- Film thickness primer: 35 µm (horizontal) and 30 µm (vertical)

The cars are painted in uni (solid colour) and metallics

- Uni film thickness: 25 µm (horizontal) and 20 µm (vertical)
- Metallic film thickness: 15 µm (horizontal) and 12 µm (vertical)

The International Experience

Clear coat is then applied over the metallic finishes.

- Clear coat film thickness: 35 μm (horizontal) and 30 μm (vertical)

The water-based paints are applied by Durr (EcoBell) robots for the exterior surfaces. The door shuts are painted by humans using Ecco 40 spray guns.⁹

Workers are required to wear overalls, gloves shoes and an air-fed mask.

Drying on the production line is in three zones: infrared, convection and cooling. There is an intermediate oven between the base coat and clear coat.



Painting the door shuts on the production line

Each car has a total time in the paint shop of six hours.

Finished Products

The Ford Cologne plant produces three and five door Fiesta's as well as the Fusion.

Ford has 15 different base coat colours, 12 metallic, and three uni (solid colours) online. There are two different clear coats, a standard clear coat and a red tinted clear coat for the hot magenta colour.



Finished car. Colour: hot magenta. This is a tinted clear coat colour.

⁹ <http://www.ecco-gmbh.de> (image)

The International Experience

Meeting Information

Since 2000, Ford has cut its global energy use by nearly one third, in part by upgrading plants with more efficient equipment. Having an environmentally friendly reputation is very important to the staff at Ford Cologne.¹⁰

In the past, waste paint was taken to landfill sites, but as of 1st June 2005 untreated waste in Germany can no longer be deposited in landfill.

Ford has a system whereby waste paint is separated from the water. Some of the paint is used in the production of cement, and the remainder is incinerated to produce electricity for use by the plant. Ford is landfill free.

Spray guns for hand use in the door shuts are Ecco 40. Durr EcoBells are used in the production line to apply water-based colour and the Esta machines are used for applying clear coat.

The cars are totally submerged to be pre treated and to apply the electro-coat. This is a dipping process. Spray booths have convection heating and infra red is used to speed the drying process.

Ten years ago the paint production line changed over to water-based paint to comply with European VOC laws and to create a 'greener' factory. Cologne was the first Ford factory to introduce water-based paint into production.

Cars are checked after painting. A decision is made as to whether the car will need to be redone or repaired. If a car needs repair it is taken off the production line, and repaired as for in the refinish trade and then slotted back on to the production line again. Most repairs would be minor, an example could be that the painter painting the door shuts may accidentally brush against the body or a door of the vehicle. After a repair, a tack rag must be used to help keep the job dust free.

The Ford paint team believes that the job an individual does is only as good as the job done by the previous stage of production. In order for workers to keep up a very high standard, job rotation is very important in order to alleviate boredom. This allows for a top quality job as close to perfect as can be achieved on every vehicle.

¹⁰ Dr Wulf-Peter Schmidt (Cologne, Germany) Vehicle Environmental Engineering, Ford Europe was awarded the '06 RMIT University/ISS Institute International Fellowship sponsored by RMIT University.

Dr Schmidt has a PhD in environmental engineering in the field of recycling and Life Cycle Assessment and has published over 60 papers. He has been with Ford-Werke AG since 1997 working first-hand in the field of LCA Design for Environment and Environmental Strategy. He is now Technical Specialist in Vehicle Recycling Research Projects, Design for the Environment, LCA and LCC, cross-carline product and product development support. His areas of specialisation are • Design for Environment • LCA • Life Cycle Management Sustainable Vehicle Design Vehicle Recycling • Integrated product policy (IPP). Dr Schmidt belongs to the Editorial Board of 'The International Journal of Life Cycle Assessment'.

The focus of Dr Schmidt's Fellowship was the following skills deficiencies • Industrial design • Overview about the tools to assess economic, environmental and social aspects of products/processes, within economies and purchasing • Determining what tool is best to use for what question/situation • Where there is an environmental business case • What an environmental business case is • Pros and cons of an efficiency approach • Designing an environmentally-favourable product with high durability and modularity • Design a product based on service ideas • The consumer's perspective • Definitions, historical roots, current legislative frame work (Europe), opportunities for companies, consumers and the environment.

Dr Schmidt's Fellowship Program encompassed conducting a workshop, public lecture, research and student seminars and participation in the ISS 'Skills Network Australia Think Tank. Design+Sustainability+Manufacturing'. Further skills and learnings arising out of this Fellowship were addressed by Nova McNamara, Materials Specialist, Recycling and Sustainability Asia Pacific and Africa, Body and Exterior Engineering, Materials Engineering, Ford Motor Company of Australia Limited. She was awarded The Pratt Foundation/ISS Institute Overseas Fellowship, supported by The Pratt Foundation, in 2008. In brief, she researched • Vehicle recycling • Recyclability requirements, substance use restrictions and parts marking conformance for end of life recycling and environmental measures • Understanding the impending CO₂ legislation and the strategies to reduce fleet CO₂ • EU legislations requirements and processes.

The International Experience



Workshop Visited: Germany – Reustle GmbH

Benzstraße 1, 74369 Löchgau, Germany

Reustle is a family owned small business in Löchgau near Stuttgart. They began using water-based paints in 2003. The paint of choice is the Glasurit Autolack system.

In the spray booths flexible, adjustable dryers are used as well as hand held paint dryers. Convection in booth heating is used and portable infrared lamps are used to decrease flash and curing times. Spray booths are positive pressure down draught booths.

Colour matching is mainly done with a spectrophotometer due to the very low natural light levels in winter.

Spray guns used are the SATAjet 3000 HVLP and DeVilbiss GTi HVLP.

The types of vehicles that are repaired here are by Aston Martin, Porsche, Opel, BMW, Mercedes and Audi.

An all tiled wash-down area is used for washing all cars before they start work, and workshop wheels are put on to prevent damage to expensive original wheels, while the car is in the workshop.



One of Reustle's tiled booths with hand made flexible dryers

The International Experience



The picture above left shows a worker doing a small repair using the paintless dent repair as a part of the SMART repair system.

The picture above right shows the preparation area with overhead drop sheets to eliminate dust to a confined area when dry sanding.

The cars are all driven onto hoists, so that the workers are working at waist level and are not having to bend over to work on the lower panels.

Paint mixing is done in a separate room with a temperature controlled cabinet for storage of water-based paint. This is essential especially in the cold European conditions, as the water-based paint is unusable after it has reached freezing temperatures.

The painters do not have any problem moving from solvent-based to water-based paint. They found that colour matching was easier and provided better results. Rubbing through a top coat clear is a problem when using solvent-based paints as one either has to prime or use a sealer, then colour then clear. With water-base, there is only the need to spray colour and then clear. Problem solving is far easier with water-based paint.

Workshop Visited: Germany – Karosserie + Lack Brixner GmbH

Baumwaide 18, 74360 Ilfeld-Auestein, Germany

In 1963 Edwin Brixner started this family owned business, which is now into its second generation.

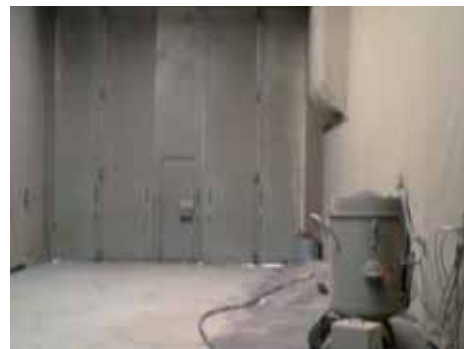
The company currently employs 30 people including office staff, spray painters and panel beaters. The work carried out on the premises includes smash repairs on cars and trucks, SMART repairs, custom built trucks (eg horse floats and refrigerated vans) and restoration work (Old Timers). The paint of choice is Spies Hecker and they have been using water-based paint for six years.

Brixner uses positive pressure down draught booths with paint curing technology. They have a heating and air movement device that increases production by reducing curing time. They also use hand held dryers and portable infra red lamps for specific small areas.

The International Experience



Spectrophotometer



Sand blasting booth

Colour matching is done using a spectrophotometer.

Sanding is done wet and dry, and dry sanding. Sand blasting booths are used for trucks and restoration work.

Sand blasting booths can accommodate the largest of trucks. Trucks are also painted with water-base paint. All the preparation areas, including truck repair area, panel beating, sand blasting and spray booths are all at the one location. This helps with work flow and allows for more efficient work practices.

If paint is being applied over plastic filler, at present there is no problem as at this repairer they are still using solvent based primers.

Brixner also paint custom truck bodies and undertake alterations and refurbishment of refrigerated trucks and custom horse floats.



Spray booth for trucks



Early German-made car

Custom restoration work is also a large part of Brixner's business. The car seen above right is an NSU and early German-made car.¹¹ This particular car has been painted in water-based paint. SATA spray guns as well as SATA filtration systems for oil and mist reduction and SATA gun cleaners are used in the spray booths.

¹¹ The owners took the name NSU from the first letters in the names of the rivers surrounding the plant: Neckar and Sulum. The company was bought by FIAT in 1928, and later sold to VW/Audi in 1969.

The International Experience

Waste Disposal

In Germany, dry paint is disposed of as for industrial waste. The overspray which is collected by the filter of the spray booth is dry, so the paint shops collect the waste and dispose of it in plastic bags. The bags are placed in a container which is picked up by specialised companies for disposing industrial waste. The small paint shops believe that the VOC regulations do not cover this type of waste disposal.

Water-borne cleaners are only used for water-borne paint. For the correct disposal the specialised waste disposal companies check the waste with a chemical test to determine the solvent concentration in the waste. This material is difficult to use as an energy-resource, because of the very high flashpoint. Accordingly, the disposal of water-borne gun cleaners is very expensive.

Brixner holds a large stock of paint and rather than being in a temperature controlled cabinet, they have a temperature controlled paint room.

Brixner puts through 25 cars and ten trucks per week. Their turnover is constant and efficiently managed.

Workshops Visited: United Kingdom

Contact: Kevin Cooper, Technical Manager

Cooper is the Technical Manager in the UK for De Beer and Octoral paints. He organised visits to the following paint workshops in the Midlands area: Waites Car Body Repairs, Milton Keynes Paint and Equipment Ltd, Hilton Coachworks, Scot Group Ltd (t/as Thrifty), and AvailableCar Limited.

Cooper left the shop floor ten years ago and has been a technical advisor for three different brands promoting water-based paint. The brands are De Beer, R-M and Glasurit. He also worked for BASF Wattle Coatings (Glasurit) as the National Head Trainer in Australia for three years based in Sydney, and then moved over to Perth working for the distribution firm, Robayne, for a following two years. He has been working back in the UK for three years and working for De Beer for the last 18 months.

Workshop Visited: United Kingdom – Waites Car Body Repairs

Unit 12 Osier Way, Park Street Industiral Estate, Aylesbury, Bucks, HP20 1EB

Waites is a small business with just two men operating the workshop. They carry out small repairs, mainly on cars, getting them ready for re-sale (used cars). Throughput weekly is approximately forty cars. Large repairs are sent out to another panel shop and then brought to Waites for painting.

De Beer paint is used in the workshop and is stored in a temperature controlled cabinet. The two workers share one down draught booth, which has convection heating and infra red heating for smaller jobs. The infra red heating allows for small jobs to be finished more quickly allowing for faster throughput of work. Hand held dryers are fitted to stands in the booth for drying water-based colour.

The International Experience



Colour matching is done by eye and with spray gun techniques. Due to the high number of cars needing to be put through weekly, the colour matching skills are of a high skill and neither of the workers have any difficulties matching any given colour.

Lighting conditions inside a UK bodyshop are rarely ideal. Fixed lighting and unpredictable weather conditions make precise decisions difficult. Inside the workshop or the spray booth, the 3M™ PPS™ Colour Check Light (above) provides near perfect daylight conditions and is often used to provide a light as close to natural daylight as possible. It is also used in the booth to reduce the chance of re-work related to colour mismatch and lack of coverage.

Dry sanding is the preferred method of preparing the vehicles using vacuum cleaners to keep the dust to a minimum. SATA spray guns are used.

Workshop Visited: United Kingdom – Milton Keynes Paint

Milton Keynes Paint and Equipment Ltd (MKPE), Newberry House, Michigan Drive, Tongwell, Milton Keynes MK15 8HQ

Contact: John E Moore, Business Development Manager



Milton Keynes Paint facility

The International Experience

MKPE is located on a two-acre site in Milton Keynes and in 2008 opened a new training centre to deliver the very latest body and paint training to the industry.

The 36,000 sq ft facility, located within its distribution zone, provides a wide range of courses for repairers, refinishers, apprentices and manufacturers' body and paint programs.

Terry Elliot, Managing Director of MKPE, joined the family owned business two years after it was established in 1971 and has seen many changes in the industry.



Training paint spray booth



Training paint mixing room (temperature controlled)

Says Elliot: *"With the increasing complexity and sophistication of vehicles there has never been a greater need for competent technicians"*¹²

MKPE has the latest up-to-date spray booths, robotic drying technology and camera systems so that the employer can link in to the classroom to see what activity his employee is undertaking. They lease all their major equipment for training purposes. When a new product is released the training facility is upgraded.

Services that the centre offers are in-house colour matching, on-site technical training, an in-house technical support team, gun wash machine rental and servicing, repairing hand tools, air quality checks equipment checks, SMART repair program and training, and spray booth servicing.

MKPE can provide a service that disposes, reuses and/or recycles waste that is being produced, whilst complying with the imposed regulations and ultimately reducing costs. They work in partnership with Pure Clean Waste Management. MKPE can safely dispose of waste thinners, paint, various colour coded containers and paint tins, and body shop booth filters.

MKPE works with various paint manufacturers, distributing their paint and using it in their training facility. Paints used include Glasurit, STANDOX, NEXA Autocolor, PPG, Max Meyer and Octral (the main selling paint).

¹² https://corporateportal.ppg.com/NR/rdonlyres/ED695AA2-42FF-4DD3-AB53-9535714789FC/0/PPGRefinisherNovember2008_final.pdf

The International Experience

Workshop Visited: United Kingdom – Hilton Coachworks

Raynham Road, Bishop's Stortford, Hertfordshire, CM23 5PJ

Contact: Peter Hilton

Hilton Coachworks was founded in 1984 by Peter Hilton. They have moved premises four times since then and are now located in a purpose built facility with 3,000 sq ft of workshop space.

The paint workshop consists of four drive through spray booths with four full time painters, five full time panel beaters, six strip and fit workers, five paint preparation staff, and five detailers. Overall the company employs 70 staff.

Booths and drying facilities were very similar to other workshops, with down draught booths, infra red and hand held dryers. There was an extremely high turnover of work. All the painters can remember painting with solvent-based paint, but are extremely happy with the water-based paint and have had no problems in changing over. Most painters believe that the job is faster with water-based paint.



Hilton Coachworks



Applying a drop coat in the spray booth wearing appropriate safety equipment

The only problem that they found early on was that they were using their old solvent-based guns and they started corroding and, therefore, caused a problem with the paint finish. When they changed to guns developed for water-based paint the problem disappeared.

The Painters use a 3M™ PPS™ Colour Check Light to check the paint finish to make sure they have good coverage before applying the clear. This saves the job being finished and then discovering that there has not been enough colour applied. Glasurit and De Beer paint is used.

Hilton Coachworks is the largest repairer of Mercedes-Benz passenger cars in the UK and are also registered with Volkswagen, Audi, Chrysler, Landrover, Suzuki and Lotus.

Management staff are heavily involved in using the ICRIS system to refine total costs, determine the amount of paint used for each job and to make sure there is minimal waste. Reducing the amount of left over paint saves in the total cost of paint as well as waste disposal costs.

The International Experience

Workshop Visited: United Kingdom – Scot Group Ltd (Trading as Thrifty)

Haunchwood Park Drive, Galley Common, Nuneaton, Warwickshire CV10 9SR

The Scot group is the owner of all Thrifty car rental vehicles in the UK. Their workshop in Warwickshire is the repair centre for all their rental vehicles. White vans, MPVs, small trucks and all types of cars owned by Thrifty are repaired in the workshop. They have four spray booths with heating and air movement devices that increase production by reducing curing time. They use De Beer Waterbase 900 system and DeVilbiss spray guns.

Paint preparation staff ready the cars so that they can go straight into the booths to be painted by the tradesman painter.



One of the four booths being used



Cars are lined up ready to go into the spray booth to be painted

The picture above right shows a spot repair on left rear quarter. Reverse masking on swage lines is applied to help keep the repair as small as possible and allow the job to be done quickly without the use of too much paint. The infra red lights are kept in one spot instead of having to be moved around to dry the entire guard.



Dryer stands



The DeVilbiss air filtration system

The stands and dryers have been used in the booths since the Scot Group started using water-based paints approximately six years ago.

The International Experience

Workshop Visited: United Kingdom – AvailableCar Limited

Orchard Way, Calladine Business Park, Sutton In Ashfield NG17 1JU

Contact: Russell Needham

AvailableCar is a UK-based used car supermarket. Approximately ten truck loads of cars come to the centre every working day and there are approximately two thousand cars in the yard. The cars are lined up in a huge car park type area where they are evaluated for the type of repair that will need to be performed (either SMART repair or smash repair). The cars are then labelled with the work that needs to be done and they are placed in a priority listing for each of the workshops, SMART or smash repair.

AvailableCar use De Beer paint and have two adjustable air flow booths in each repair area. They use positive pressure down draught booths with paint curing technology. AvailableCar have a heating and air movement device that increases production by reducing curing time. It is a must to have this type of booth technology in order to get the cars through the workshop as quickly as possible. They also use hand held dryers and portable infrared lamps for specific small areas.



AvailableCar Limited



Hand held dryer with interior filters in order to reduce the chance of dust being blown onto the paint work



Inside the workshop

Workshops such as AvailableCar are known as refurb centres in the UK. In Australia this type of work is known as used car work. All work is in preparation for resale. There is no insurance work carried out in these centres.

Knowledge Transfer: Applying the Outcomes

Numerous car companies have moved or are moving towards the use of water-based automotive paints, especially in Europe. These include, but are not limited to BMW, Mercedes-Benz and Volkswagen. Australia is in the process of adopting this technology.

Waste Handling

In Germany and the UK dry paint is disposed of as industrial waste. When spray booth filters are full of dried paint, they are removed and placed into plastic bags, placed in a container and the waste is normally collected by a local authority/agency or contractor and disposed of as dry industrial paint waste.

To handle the filters, workers must have full disposable overalls, safety boots, gloves, protective glasses and a charcoal filtered respirator as there should only be dried paint in the filter.

When spraying water-based paint and air-fed hood should be used. Therefore, there will be no need to replace filters. Respirators with charcoal filters are not recommended for spraying water-based paint.

Booth filter replacement will depend on the usage of the booth. The booth indicator dials will show a change in pressure when the filters are dirty and require replacement.

For the correct disposal of the water-based gun cleaning liquid, specialised waste disposal companies have to check the waste with a chemical test to find out the concentration of solvent in the waste. This material is difficult to use as an energy-resource because of the very high flashpoint. So the disposal of waterborne gun cleaners is very expensive. This can be reduced by using a flocculating agent to separate the paint waste from the cleaning fluid.

Flocculating agents have been developed for the easy and efficient treatment of waste water contaminated with paint residue during the spray gun cleaning process. The process involves adding a powder to the waste water and stirring until the solid waste settles to the bottom. The liquid can then be filtered off and reused.

The sludge collected is classified as 'controlled waste' and should be disposed of according to local regulations.

The filtrate can be re-used a number of times for cleaning spray guns and is termed as recycled water. The recycle option is only recommended for a manual spray gun cleaning machine. The recycled water can be used for a maximum of ten times before being replaced with clean water.

The liquid produced for the waste treatment process should not be disposed of in a public sewer, unless one has special advance authorisation from a local or national water authority.

If paint is stored for longer than the shelf life of mixed paint that is six months, then it must be disposed of as controlled waste.

Implementation of Water-Based Paint Systems into Everyday Work Practices

Water-based paint is available in Australia, but not widely used due to the fact that it is not compulsory to meet VOC standards as yet. All of the paint manufacturing companies understand the use and disposal of waste from water-based paint systems, as they are all from overseas and have to meet the VOC standards.

Knowledge Transfer: Applying the Outcomes

Europe and America have been using these systems for up to ten years and have a knowledge and understanding of the correct procedures. The information is readily available and should not be difficult to implement in the Australian workshop.

Minor changes need to be made to current workshop practices in order to fully implement a water-based system:

- Storage of paint needs to be temperature controlled
- Booths need to have additional heating and air flow – infra red heating or blowers on stands for small jobs
- Water-based specific spray guns
- New gun cleaning equipment – solvent cleaning and water-based cleaning must be kept separate
- Masking tape (paper and plastic) designed for use with water-based paint
- Paint strainers should be water resistant and have a minimal mesh size of 125 microns

In Australia, there have been many new methods demonstrated for the use of solvent-based paint application. After researching water-based systems it seems that these 'new' methods are methods developed for the application of water-based paint. These methods are being introduced into the Australian workshops still using solvent-based systems and will allow for a very easy transfer of skills to a water-based system.

Colour Matching

Colour matching techniques have changed over time and now, when using water-based paint, the techniques for colour matching have improved greatly. Water-based paint sits differently on the panel to solvent-based paint and when one applies a drop coat it gives the illusion of an almost (if not) perfect match.

Spectrophotometers reduce time when colour matching. It is anticipated that that they will be used increasingly as water-based colour matching is taken up. Spectrophotometers have improved in their ease of use and accuracy and have reduced in price so they are more affordable for a small workshop.

Blending techniques have become a large part of colour matching. In earlier times a painter would paint solvent-based paint at high pressure to blend out. With the water-based system and low pressure (HVLP), the blend does not need to cover as great an area. A painter can blend to a swage line rather than complete panels. This saves time and product.

This technique requires a new set of skills and needs to be learnt by the painters in order for the workshop to save time and money. Older methods of blending can still be used, but it has been found to be costly, as one has to mix up a larger amount of paint and it will take longer to apply and dry. This takes up booth time and work flow slows down.

Surface Preparation

If paint is being applied over plastic filler, at present there is no problem as most repairers are still using solvent-based primers.

Companies manufacturing plastic fillers are currently looking into plastic fillers that can have water-based primers applied directly over the filler without being absorbed into the filler and reacting with the metal underneath.

Knowledge Transfer: Applying the Outcomes



Car repaired using plastic filler at Brixner GmbH, Germany

Paint Application Techniques

In the factory situation (Ford, Cologne) the door shuts are hand painted using Ecco 40 gravity feed spray guns. Two coats of base coat colour and one coat of clear are applied.

The automated system applies two coats of base coat colour with the Durr (EcoBell) and one coat of clear with the ESTA clear coat robots.

In the repair workshop a dust coat is applied to imitate the factory finish. This is followed by two wet coats which, once dried, is followed by the application of a top coat. A clear coat is then applied which is referred to as a 'tack and whack' coat. The tack coat is a fast quick application followed by the whack coat which is a normal wet application. This provides a finish as close as possible to the factory finish. 'Tack and whack' is a term used by painters, but is not an official painting term and is not referred to in any technical information sheets.

Drying Processes

Drying is an important aspect in the water-based process. With no air flow or not enough heat the paint stays wet and does not allow for the extra coats to be applied and the job to be finished.

To aid in the drying process there are a number of optional methods that can be used to speed up the drying process. These include:

- Stationary drying units
- Hand held dryers
- Infra red drying systems
- Extra air flow devices fitted to the spray booth
- Fast temperature adjustment devices fitted to the spray booth

Knowledge Transfer: Applying the Outcomes

Spray Gun Technology

Spray guns must comply with VOC regulations for solvent emissions to protect the environment. They have a transfer efficiency rate of 65 per cent and above.

Spray guns need to have optimum corrosion protection. Corrosion-resistant material passages are generally made of stainless steel. The material nozzle and paint needle are made of stainless steel and have nickel plated brass air caps. Adapters for indicating air pressure (psi, kpa, and bar) are useful when adjusting air pressure for optimum spray technique as advised by the paint manufacturer.

Recommendations

Government

Recommendation: Federal, State and Territory Governments should give priority to implementing nation-wide VOC regulations for the automotive refinishing industry that are compatible with current EU and US regulatory frameworks.

Information in this report needs to be brought to the attention of relevant government departments and agencies responsible for the environment, sustainability, environmental protection and workplace safety as a resource to build an effective regulatory regime for the automotive refinishing industry.

Effective regulatory requirements will be an important driver in increasing industry understanding of the benefits of moving to water-based paint systems. It was not until the VOC laws in Europe were brought in that the repair industry saw the real advantage of using the system.

Industry

Recommendation: Use TAFE facilities to provide workshops and trade information sessions.

The introduction and operation of new regulatory arrangements mandating the use of water-based paint systems will happen more smoothly if there is co-operation and communication between government, individual vehicle repair businesses, relevant motor vehicle industry associations, product suppliers and educational institutions.

A series of workshops/information sessions should be developed and delivered to demonstrate the aforementioned water-based paint systems with trade students and teachers preparing panels through the day and tradespeople, insurance companies and distributors invited to attend and 'experience' the new paint system.

Training programs are taking place at paint company training facilities, private workshops and at some TAFE institutes. These need to become more widespread and promoted.

De Beer Australia has generously donated to the Wagga Wagga Campus of TAFE NSW a 900Series water-based paint system. The system is being used by students enrolled in the vehicle painting course. It is envisaged that evening post-trade courses will also be offered in 2010 to inform tradespeople on the economic and environmental advantages of water-based paints.

Education and Training

Recommendation: Revise and update relevant components of the TAFE teaching syllabus relating to water-based paint, to incorporate practical and theoretical knowledge of the paint and associated products, with particular emphasis on the units AURV329603FA and AURV371481A.

The AUR30805 is the section within the training package relating to the vehicle painting industry. It is from this training package that TAFE NSW has developed the Certificate III in Automotive Vehicle Body (Specialising in Vehicle Painting). All industry associations relating to the Motor Vehicle Repair Industry will be using the AUR05 training package as the basis for any accredited courses they offer.

The nationally accredited AUR05 Automotive Retail, Service and Repair training package includes training outcomes for the vehicle body repair industry.

Recommendations

At present the unit *Apply water-based refinishing materials* (AURV329603FA) is an elective and, therefore, not necessarily covered by all apprentices coming through TAFE. Other units can use water-based paint (eg AURV332308A – *Carry out custom painting techniques*) are not compulsory and are left to the discretion of teachers as to how those courses are delivered and what is covered.

Recommendation: Increase knowledge of water-based paint systems among TAFE teachers
TAFE teachers in each state should be made more aware of what is happening overseas regarding VOC regulations. Greater awareness and understanding of the advantages of water-based paints will assist in the smooth the introduction of water-based systems into Australian repair workshops.

All of the major paint companies have a water-based product range available. With the TAFE teachers gaining expertise in this area, it would help build a better relationship between the TAFE and the paint companies. Eventually water-based paint systems will be thrust upon the industry whether they like it or not and if workshop managers embrace the technology and see it as an improvement, it will be much easier to implement.

ISS Institute

The Institute continues to be committed to developing awareness of sustainability and recycling across industry sectors including those industries which use paint-related products. It is proposed that government, industry and peak industry bodies fund ISS Institute to build further depth of skills and knowledge in this important field.

References

Reports

'Waterbourne Coatings, Pollution protection in auto body and paint shops', September 2006, Doc. No 801, Department of Toxic Substance Control, California

Websites

Ecco

<http://www.ecco-gmbh.de/>

EUROPA, European Commission, Environment, Air, Emissions of Air Pollutants, Solvents in Paints and Vehicle Refinishing Products, Directive 2004/42/CE Summary

http://ec.europa.eu/environment/air/pollutants/paints_directive.htm

Sata Product Leaflets

<http://www.autoblog.com/2008/08/14/cologne-plant-begins-pumping-out-new-fiesta/>

'The Refinisher' Issue 16 November 2008

https://corporateportal.ppg.com/NR/rdonlyres/ED695AA2-42FF-4DD3-AB53-9535714789FC/0/PPGRefinisherNovember2008_final.pdf

US Environmental protection agency Technology Transfer Network Air Toxics Web Site, Glycol Ethers

<http://www.epa.gov/ttn/atw/hlthef/glycolet.html>

Attachments

Index to Attachments (Refer to CD)

Attachment 1 – General Safety

Attachment 2 – DeBeer Program

Attachment 3 – DeBeer Certificate

Attachment 4 – Sata Welcome

Attachment 5 – Sata Program

Attachment 6 – Sata Certificate

Attachment 7 – Anest Iwata Blow Dryers

Attachment 8 – Anest Iwata Spray Guns

Attachment 9 – Mercedes Magazine

Attachment 10 – Symach Handbook

Attachment 11 – Symach Easy Dry

Attachment 12 – Symach Fly Dry

Attachment 13 – Symach Robo Dry

Attachment 14 – Symach Robots

Attachment 15 – Riverina Institute of TAFE Website Story