CONTENTS

SECTION F PLANT AND EQUIPMENT

Lesson 18 - Transporting Coating Materials
Lesson 19 - Air Movement, Drying and Curing
Lesson 20 - Ancillary Operations

SECTION H SERVICES

Lesson 21 - Water chemistry, Utilities and Prime Services

SECTION I - CONTROLLING THE PRODUCT AND PROCESS

Lesson 22 - Testing of Coatings
Lesson 23 - Troubleshooting Coating Defects and Process Control

SECTION J - HEALTH, SAFETY AND ENVIRONMENTAL ISSUES IN SURFACE FINISHING

Lesson 24 – Health, Safety and Environmental Legislation
Lesson 25 – Health and Safety Hazards and Precautions
Lesson 26 – The Treatment and Disposal of Finishing Wastes

APPENDIX 1 Self Marked Assessments
APPENDIX 2 Marked Assignments
APPENDIX 3 Glossary of Terms
APPENDIX 4 Example Examination Questions
APPENDIX 5 Examination Regulations

PREFACE

This distance learning module is based on the notes for the tutored course module that has been offered for several years by the Institute of Materials Finishing.

Changes and additions have been made to the original notes to take into account the various technical innovations that have taken place in more recent years and, in particular, the changes in environmental, health & safety practices and general changes in industrial working.

One major change has been to ensure that study by distance learning mirrors the course offered by the tutored route. The Objective Syllabus for both paths is now identical and the courses are examined in the same way, both leading to the same qualification and certification.

The Institute appreciates the hard work in carrying out this revision by Clive Barnes and Trevor Crichton. Further, thanks are expressed to all those other members of the Institute who have contributed by way of offering advice, reading of revised lessons etc.

INTRODUCTION TO DISTANCE LEARNING AND THIS MODULE

Distance Learning differs from the traditional method of learning that you may have been used to in school and in further study. The traditional method of learning has a fixed rate of progress guided by a lecturer and the group proceeds at a fixed speed. The study rate for some individuals may be too slow and too fast for others. Generally all have to commence at the start of the course and if you miss some teaching there may be no way in which to catch up.

Distance Learning is not a new concept and been around for several decades. With some of the IMF's earlier modules, a set of written notes and a set lectures on pre-recorded tapes (later changes to CDs) was provided. Feedback from students advised us that script lecture notes were preferred to the tapes and CDs, and so more recently, students studied the script version alongside the set of notes.

The 2010 revision has integrated the scripts with the notes so that every individual lesson is a complete unit. The 2010 revision has also subjected the technology to a major revision and provided an opportunity to include on the newer technologies introduced in recent years.

As you are aware, you have been linked to an 'Industrial Counsellor' who hopefully is an employee from your own company. The purpose of this appointment is that there will be times when you may not have completely understood a statement or equation in the module and the purpose of this counsellor is to assist you on such occasions as this. If a suitable person is not immediately available within your company then the Institute will have made arrangements to have linked you a suitable local member of the Institute who has agreed to be available to assist you if possible. Most importantly. do not become disheartened in your studies. If on any occasion your Counsellor is unable to answer your query, you should contact The Education Manager at The IMF's Head Office who will arrange for a Professional Member to contact and assist you.

When studying always have a 'pad & pencil' at your side so that you can make notes of some important sections. These notes can be very useful when you need to revise or obtain further elaboration.

So how is this module made up? You have a set of study notes of various lengths composed of written text intermixed with some illustrations. These need to be read several times to make certain you have understood before moving on to the next lesson.

At various positions in the lessons you will see items headed SAQs, SMAs and MAs.

SAQs - Self Answered Questions

As you work through the Lessons, periodically you will come across an SAQ. This will be a question relating to what you have just studied. The purpose of the question is to check that you have understood the Lesson so far. Firstly, you should try to answer the question without checking back through your notes and then check you answer with the model answer provided

at the end of the Lesson. If your answer is correct, it is safe to continue with the next part of the Lesson. However, if you are unable to answer the question or have incorrectly answered the question, before proceeding any further, it is advisable that you re-read the Lesson.

SMA – Self Marked Assessment

At the end of some Lessons, you will find a series of questions that you should attempt to answer. The questions will be relevant to the lesson that you have just studied. Four or five possible answers will be listed for each question and you should circle the answer that you think is correct. When you have completed the series of questions, check your answers against those given at the end of the Lesson where you will find a short explanation of why each possible answer is correct or incorrect.

These SMAs, both questions and answers, are also included in Appendix 1 and can be a useful source of revision prior to your examination.

MA –Marked Assignment

A series of assignments (4 in total) are to be carried out during your studies; these assignments cover some of the objectives of the Module. They are designed to test that you have understood sections of the study material and can use the knowledge gained to suggest answers to a specific problem or situation. In the traditional system of learning, these would have been called 'homework'.

You will find detailed instructions on how to carry out the assignments in Appendix 2. You must pay particular attention to the information regarding **plagiarism.**

After completing each assignment, it should be sent to the Institute to be externally marked. (**NOTE** Students on tutored courses will have their assignments marked by their tutor.) Once marked, it will be returned to you. The total marks you receive for the four assignments contribute up to a maximum of 20% towards your final examination mark, so you are rewarded for your efforts.

Please note: marked assignments are compulsory and must be submitted by the due date for you to be eligible for the final examination. This is fully explained in Appendix 2 and Appendix 5.

The Examination

The 2 hour examination consists of two sections:

Section A 5 short essay questions, all of which should be attempted, for which it is suggested you should allow about 30 minutes for your 5 answers.

Section B consists of 8 longer essay questions and you should attempt five of these questions; it is suggested that you allow about 16 minutes for each answer.

Section A gives up to a maximum of 25% of the total marks and Section B gives up to a

maximum of 75% of the total marks. The answers you give will be marked by an Institute's external examiner and the examiner's mark will be modulated by the Institute's Examination and Qualifications Board.

The pass mark is 40% made up from the marks you received from your MAs combined with the marks from the final examination.

A mark of 60% and over gives a **'Pass with Merit'** whilst a mark of over 75% gives a **'Pass with Distinction'.** If you achieve these marks, the credit will be shown on your certificate. (An average mark of at least 40% must be obtained for the 4 assignments for a merit or distinction to be awarded)

NOTE: Candidates whose first language is not english may use a dictionary book during the examination, other types of dictionary, e.g. electronic ones and technical dictionaries, are not permitted. The examination's invigilator will check that the dictionary is suitable before the start of the examination. (Examples of suitable dictionaries are standard english dictionaries and dictionaries providing translation from english to another language and vice versa.)

Additional Distance Learning Modules

There are additional modules of a similar academic standard. These are:

Principles of Electroplating
Electroplating Practice
Powder Coating
Environmental, Health and Safety
Materials Science
Electroforming

Any one of the above combined with the module you have just completed, can lead to the award of a **'Technician Certificate'.** The benefit here is that you can apply for the professional qualification **'Technician of the Institute of Materials Finishing' and the insignia TechIMF,** with which you can apply for the international award from the UK Engineering Council of **'Engineering Technician' and the insignia EngTech** which is internationally recognised across all industries.

OBJECTIVE SYLLABUS FOR AUTOMOTIVE SURFACE FINISHING

SECTION A - WHY SURFACE FINISHING?

Lesson 1 - Surface Finishing Techniques and Applications

At the end of Lesson 1, you should be able to:

1.1 Define surface finishing.
1.2 Describe the main processes used for Surface Finishing and their basic principles.
1.3 Describe the purposes for which these finishes are applied to substrates.
1.4 Describe the nature of the Surface Finishing Industry and its economic importance.

Lesson 2 - Properties of Different Surface Finishes

At the end of Lesson 2, you should be able to:

2.1 List the strengths and weaknesses of various surface finishes.
2.2 Decide which finish is appropriate for a particular function.

SECTION B- BASIC SCIENCE FOR COATINGS

Lesson 3 - Chemical Symbols and Chemical Equations

At the end of Lesson 3, you should be able to:

3.1 Write the chemical symbols for the chemicals used most often in surface finishing.
3.2 Write chemical equations for simple chemical reactions.
3.3 Understand how atoms join together by ionic and covalent bonds.

Lesson 4 - How Coatings Can Prevent Corrosion

At the end of lesson 4 you should be able to:

4.1 Define corrosion and understand its consequences.
4.2 Understand the chemistry of corrosion of iron.
4.3 Understand the electrochemical nature of the aqueous corrosion of metals.
4.4 Know how the electrochemical series can be used to select coatings for the prevention of corrosion.
4.5 Understand how coatings prevent corrosion.
4.6 Describe the need for accelerated corrosion tests for coated products and explain the main tests.

Lesson 5 - Calculating thicknesses, areas and volumes

At the end of Lesson 5, you should be able to:

5.1 Calculate area and volumes.
5.2 Calculate the coverage of paint and coating powders.
5.3 Calculate the cost of the paint or coating powder per component.

Lesson 6 - Adhesion

At the end of Lesson 6, you should be able to:

6.1 Discuss some basic theories of adhesion that apply to powder coatings.
6.2 Discuss some of the problems which occur at a substrate/coating interface.
6.3 Assess the effectiveness of different cleaning treatments.

SECTION C - ORGANIC COATINGS

Lesson 7 - Introducing Paints, Lacquers, Varnishes and Coating powders

At the end of Lesson 7 you should be able to:

7.1 Appreciate how chemistry relates to coating technology.
7.2 Understand the roles of polymers, pigments and solvents.
Understand the principles of coating formulation.
7.3 Name the most common polymer resins used in liquid coating formulations.
7.4 Explain how the structure of different polymers imparts different properties to the coating.
7.5 Learn about coating powders.

Lesson 8 - Aspects of Formulation of Organic Coatings

At the end of Lesson 8 you should be able to:

8.1 Understand the principles of coating formulation.
8.2 Name the most common polymer resins used in liquid coating formulations.
8.3 Appreciate how paints are manufactured and thus understand their behaviour.
8.4 Be knowledgeable about the properties of coating materials.

Lesson 9 - The Nature of Automotive Finishes

At the end of Lesson 9 you should be able to:

9.1 Appreciate the development and important role of automotive primers.
9.2 Understand the critical aspects of surfacers and anti-chip coatings, particularly as VOC legislation becomes an issue.

9.3 Learn about different types of base coats and consider the possible future development of new materials.
9.4 Appreciate the development and use of clearcoats in basecoat clear systems. Anticipate any future role for coating powders in automotive plants.
9.5 Have a basic understanding of the testing that may be required to ascertain the suitability of coating systems for automotive use.

SECTION D - PREPARATION OF SUBSTRATES

Lesson 10 - Substrates and Their Cleaning

At the end of Lesson 10 you should be able to:

10.1 Appreciate the development and important role of automotive primers.
10.2 Understand the vital importance of surface preparation, including cleanliness and surface roughness.
10.3 Discuss methods of mechanical cleaning for substrate preparation.
10.4 Discuss the advantages and disadvantages of using solvents for cleaning.
10.5 Discuss methods of using water based systems for cleaning surfaces.
10.6 Understand the reasons for handling components for coating applications with due care.

Lesson 11 - Pretreatment with Chemical Conversion Coatings

At the end of Lesson 11, you should be able to:

11.1 Define the purposes of conversion coatings.
11.2 Discuss the chemistry of phosphating on steel.
11.3 Discuss the different types of phosphate coatings, explain their uses and be able to select the right one for products under different environmental conditions of use.
11.4 Describe the layout of a typical phosphating plant.
11.5 Discuss the use of chromate conversion coatings on different metals.
11.6 Know that safer alternatives to phosphating and chromating solutions are now available

SECTION E - PREPARATION FOR PAINTING

Lesson 12 - Working with Paints, Lacquers and Varnishes

At the end of Lesson 12 you should be able to:

12.1 Explain the practical precautions to be taken when working with coating materials
12.2 Understand the initial preparation of the coating material prior to application.
12.3 Discuss the initial testing necessary to ensure that the coating material is suitable for application.
12.4 Carry out standard tests to establish application criteria and parameters.

SECTION F - APPLICATION OF COATINGS

Lesson 13 - Application of Paints, Lacquers and Varnishes by Non-Atomisation Techniques

At the end of Lesson 13 you should be able to:

13.1 Have an understanding of the basic processes of coating application.
13.2 Know the decisions that are made to select the correct process.
13.3 Describe techniques for coating small components such as fasteners.
13.4 Know the advantages and disadvantages of the various dipping techniques.
13.5 Describe automated processes for coating high volumes of simple shapes.

Lesson 14 - Deposition of electrophoretic and autophoretic coatings

At the end of Lesson 14 you should be able to:

14.1 Explain the electrophoretic coating process.
14.2 Understand the difference between anodic and cathodic deposition.
14.3 Explain the autophoretic coating process.
14.4 Give the advantages and disadvantages of electrophoretic and autophoretic processes.

Lesson 15 - Spray Application Processes

At the end of Lesson 15 you should be able to:

15.1 Describe conventional spray application and know its limitations.
15.2 Review the decisions that are made to select air atomising equipment and appreciate their function use and control.
15.3 Understand the environmental benefits of HVLP and airless spraying techniques.
15.4 Have an understanding of hydraulic atomisation and its variants including air assisted airless techniques.
15.5 Know the benefits of 'hot spray' techniques.
15.6 Understand the practical use of spray application devices.

Lesson 16 - Electrostatic and Automated Application Processes

At the end of Lesson 16 you should be able to:

16.1 Appreciate the benefits of electrostatic process for the application of paint.
16.2 Understand the principles of electrostatic application.
16.3 Study and compare the various designs of electrostatic paint application equipment.
16.4 List and relate the important variable parameters for equipment set-up that provide the quality and efficiency of this coating application method.
16.5 List and relate the important variable coating parameters that provide the quality and efficiency of this coating application method.
16.6 Discuss the benefits of gun movers, reciprocators/manipulators and robots.

Lesson 17 - Application of Powder Coatings

At the end of Lesson 17 you should be able to:

17.1 Describe the fluidised bed technique.
17.2 Describe the electrostatic spraying technique.
17.3 Discuss the charging of powders by the corona charging techniques.
17.4 Discuss the charging of powders by the tribo charging technique.
17.5 Describe powder feeding systems.

SECTION G - PLANT AND EQUIPMENT

Lesson 18 - Transporting Coating Materials

At the end of Lesson 18 you should be able to:

18.1 Appreciate the necessity to handle coating materials with care.
18.2 Review the various methods for feeding liquid materials to applicators.
18.3 Understand the operation of pumps.
18.4 Have a basic understanding of paint circulation systems.
18.5 Review the options for colour change
18.6 Understand the complexities of plural component systems.
18.7 Have a basic understanding of coating powder handling
18.8 Describes systems for recovering oversprayed powder.

Lesson 19 - Air movement, Drying and Curing

At the end of Lesson 19, you should be able to:

19.1 Understand the importance of air movement in the coating application process.
19.2 Review the operational facilities provided by spray booths and flash off areas.
19.3 Consider the process of overspray removal.
19.4 Explain the differences between drying and curing.
19.5 Review various types of oven.
19.6 Explain the process of infra red curing.
19.7 Understand the benefits of new curing technologies.
19.8 Discuss the essential features for curing coating powders.
19.9 Review the important design features of heating and curing equipment.

Lesson 20 - Ancillary Operations

At the end of Lesson 20, you should be able to:

20.1 Know the importance of good design of jigs and fixtures.
20.2 Describe different methods for the stripping of coatings.
20.3 Know the advantages and disadvantages of different coating stripping techniques.
20.4 Understand the need for masking parts of components when coating.

SECTION H - SERVICES

Lesson 21 - Water Chemistry, Utilities and Prime Services

At the end of Lesson 21 you should be able to:

21.1 Appreciate the meaning and purpose of utilities and prime services in the Paint Shop.
21.2 Realise the importance of water and know what it is.
21.3 Be aware of the properties of water.
21.4 Know about the treatment of water.
21.5 Be aware of the quality of deionised water.
21.6 Appreciate the value of water as a heat transfer fluid for cooling and heating.
21.7 Understand the key properties of utilities and services.
21.8 Be knowledgeable of the Factory Coding System.

SECTION I - CONTROLLING THE PRODUCT AND THE PROCESS

Lesson 22 - Testing of Coatings

At the end of Lesson 22 you should be able to:

22.1 Describe standard methods of ensuring that coatings meet quality standards.
22.2 Review test methods for assessing the visual properties of coatings.
22.3 Review test methods for assessing the mechanical properties of coatings.
22.4 Review test methods for assessing the environmental performance of coatings.
22.5 Understand the limitations of accelerated corrosion tests.

Lesson 23 - Troubleshooting Coating Defects and Process Control

At the end of Lesson 23, you should be able to:

23.1 Know how to identify the most common causes of problems.
23.2 Know how to inspect coatings.
23.3 Know how to troubleshoot.
23.4 Appreciate the benefits of process control.
23.5 Know how to use control charts.
23.6 Know about failure mode analysis.

SECTION J - HEALTH, SAFETY AND ENVIRONMENTAL ISSUES IN SURFACE FINISHING

Lesson 24 – Health, Safety and Environmental Legislation

At the end of Lesson 24, you should be able to:

24.1 Understand what is required of an employer under the Health & Safety at Work Act (1974).
24.2 Understand what is required of an employee under the Health & Safety at Work Act (1974).
24.3 Be aware of the requirements of Control of Substances Hazardous to Health (COSHH).
24.4 Understand the need for risk assessments and their relevance to COSHH and the Health and Safety at Work Act.
24.5 Be aware of the use and meanings of Risk and Safety phrases.
24.6 Be aware of REACH.
24.7 Understand the role of the Environmental Protection Act and how it relates to surface finishing.
24.8 Be aware of other legislation that may affect the processes used in surface finishing.

Lesson 25 – Health and Safety Hazards and Precautions

At the end of Lesson 25, you should be able to:

25.1 List and identify the most important items of safety equipment in a surface finishing department.
25.2 Identify the most common hazards to be found in the workplace.
25.3 Be aware of specialist hazards to be found in different type of surface finishing areas.
25.4 Know how to avoid any short and long term effects of these hazards.
25.5 Know how to avoid a fire and to mitigate its effects.
25.6 Discuss the importance and role of training in the prevention of accidents.
25.7 Be aware of the hazards in the painting environment.
25.8 Know how to design plant and equipment for painting to reduce the risk of accidents.

Lesson 26 – The Treatment and Disposal of Finishing Wastes

At the end of Lesson 26, you should be able to:

26.1 Discuss how the discharge of hazardous effluents can cause danger, damage or loss.
26.2 List the main hazardous wastes from Surface Finishing.
26.3 Explain how heavy metal ions can be removed by alkaline precipitation and flocculation.
26.4 Discuss how to minimise the amounts of waste produced.
26.5 Discuss methods for reducing water usage.
26.6 Identify how energy is wasted.