UNIVERSITY OF CAMBRIDGE

Department of Engineering

**Institute for Manufacturing**

# MET IIB Course Handbook 2024-25

# Disclaimer

We have endeavoured to ensure that the information contained in this handbook is as accurate as possible. However, it is likely that minor changes and updates may need to be made to some sections during the course of the year. This is very likely with the module timetables where, due to circumstances beyond our control, some aspects of the delivery may change.

We will ensure that all updates are communicated to you by email and/or posted on the MET IIB Moodle site.

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## People involved in MET IIB

| | | | |
|---|---|---|---|
| | **Dr Claire Barlow**<br>IIB Modules: Sustainable Manufacturing, Production Technologies and Materials | | **Prof Alexandra Brintrup**<br>METIIA Course Director<br>Industrial Project Supervisor<br>IIB Modules: Data and Decision Science |
| | **Dr Nathanial Cooper**<br>Industrial Project Supervisor<br>IIB Modules: Sustainable Manufacturing | | **Prof Ronan Daly**<br>Industrial Project Supervisor<br>IIB Modules: Production Technologies and Materials |
| | **Prof Michaël De Volder**<br>Industrial Project Supervisor<br>IIB Modules: Production Technologies and Materials | | **Prof Steve Evans**<br>IIB Modules: Sustainable Manufacturing |
| | **Dr Mark Khater**<br>IIB Modules: Strategy and Marketing | | **Dr Karel Kruger**<br>Industrial Project Supervisor |
| | **Dr Mukesh Kumar**<br>METIIA Chair of Examiners<br>Industrial Project Supervisor | | **David Leal-Ayala**<br>IIB Module: Enterprise, Globalisation and Policy |
| | **Prof Duncan McFarlane**<br>Industrial Project Supervisor<br>IIB Modules: Manufacturing Systems Engineering; | | **Prof Tim Minshall**<br>Industrial Project Supervisor<br>IIB Modules: Induction; Technology and Innovation Management, Leadership and Managing People |
| | **Dr Letizia Mortara**<br>MET IIB Course Director<br>Industrial Project Supervisor<br>IIB Modules: Technology and Innovation Management | | **Prof James Moultrie**<br>Industrial Project Supervisor |

| | | | |
|---|---|---|---|
| | **Prof Bill O'Neill**<br>Industrial Project Supervisor<br>IIB Modules: Production Technologies and Materials | | **Prof Ajith Kumar Parlikad**<br>Industrial Project Supervisor<br>IIB Modules: Advanced Operations Management |
| | **Dr Rob Phaal**<br>IIB Modules: Technology and Innovation Management | | **Dr Sebastian Pattinson**<br>METIIB Chair of Examiners<br>Industrial Project Supervisor<br>IIB Modules: Production Technologies and Materials |
| | **Dr Angkur Shaikeea**<br>Industrial Project Supervisor | | **Prof Frank Tietze**<br>Industrial Projects Coordinator<br>IIB Modules: Induction; Technology and Innovation Management |
| | **Alan Thorne**<br>Industrial Project Supervisor<br>IIB Modules: Manufacturing Systems and Engineering, Automation Lab | | **Dr Florian Urmetzer**<br>IIB Modules: Production Technologies and Materials |
| | **Prof Chander Velu**<br>Industrial Project Supervisor<br>IIB Modules: Strategy and Marketing | | |

## IfM Teaching Office Staff

**Shane Strawson**
Senior MET Administrator

**Hannah Smith**
Senior ISMM Administrator

**Bet Brooke**
Teaching Administrator

## IfM Teaching Support Staff

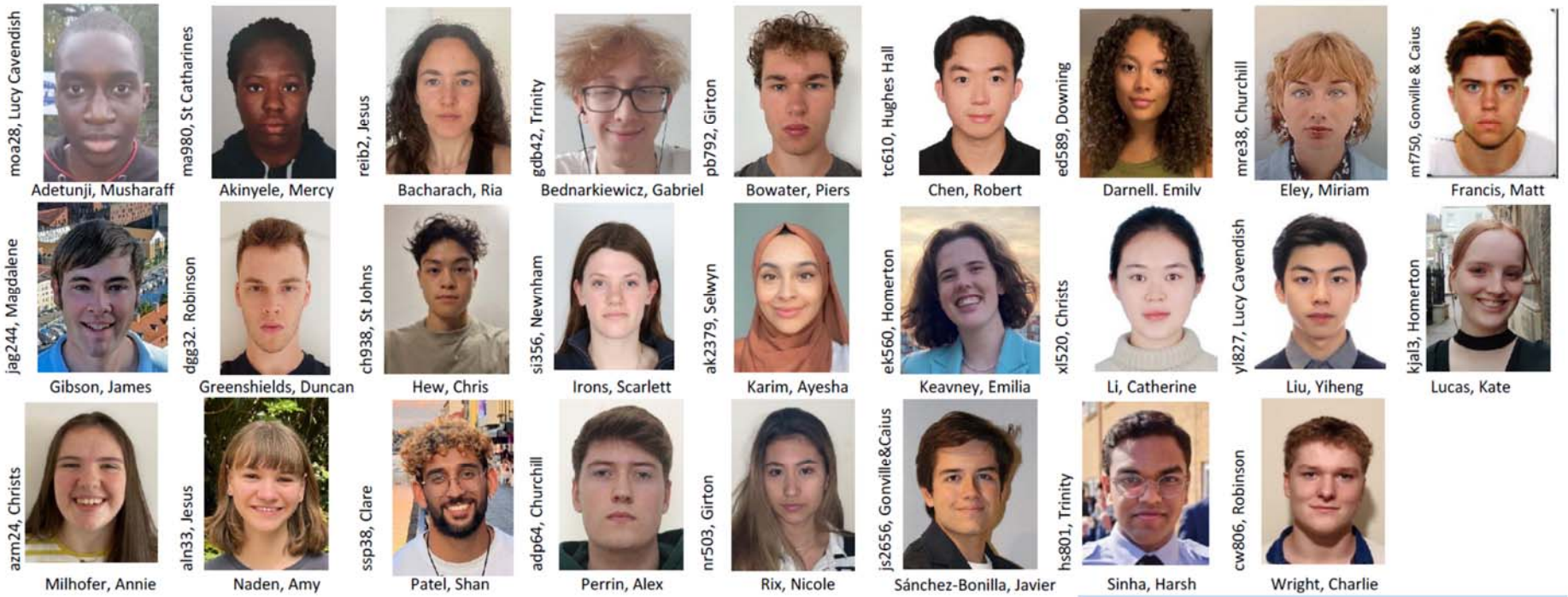
**Lewis Grantham**
Computer Officer

**Giles Hainsworth**
Senior Computing Technician

**Chris Jennings**
Workshop Technician

**Simon Sennitt**
Workshop Technician

**MET IIB students**



## Aims, Learning Style and Professionalism

### Course Aims

MET aims to provide those with leadership potential with a thorough grounding in management and manufacturing technologies, together with an understanding of the full range of industrial activities: from product design, component manufacture, industrial engineering, factory and business management through to how firms work and innovate in the economy. A core message throughout the programme is to understand how firms can grow sustainably.

### Learning style

MET IIB builds on the foundations provided in the third year, with a combination of modules introducing issues of strategic relevance to firms and modules that drill deeper into ideas introduced in MET IIA. MET IIB represents a substantial departure from the standard university timetable and approach. Modules and practical activities run in sequence, with a module typically lasting one week. Teaching in the modules is seminar based, to encourage interaction and participation. Industrial speakers supplement the theory, with examples from practice. Throughout the year, you will get to apply the taught principles in company-based industrial projects.

### Professionalism

The success of the MET depends on maintaining a close working relationship with a large number of companies. **For the course to be successful, and for us to maintain the high level of support from industry that we currently enjoy, it is essential that all our engagements with industry – be they hosting guest speakers, making company visits or working on company-based projects – are conducted in a highly professional manner.** Without spelling out what this means, a guideline is that course members are expected to behave at all times in the same way as if they were employed as professional engineers.

All MET staff take their roles as education professionals extremely seriously and want to ensure that MET is as effective and efficient as it can be at achieving the course aims. To help ensure this, there is a MET Staff Student Joint Committee (SSJC). The SSJC meets once per term and is chance for staff and students to raise any issues for discussion and action. The SSJC comprises two representatives each from MET IIA and MET IIB, the MET Senior Administrator, and the two MET directors. Volunteers for the student representative roles will be sought during MET IIA and IIB inductions.

## Key dates and assessment - MET IIB Year Planner 2024-2025

| Week no/day | Week starting | Content |
|---|---|---|
| | | **Michaelmas Full term starts Tuesday 8 October 2024** |
| 0 Mon | 7 October 2024 | Induction & Enterprise, Globalisation and Policy Module<br>**Projects** |
| 1 Mon | 14 October 2024 | Strategy and Marketing |
| 2 Mon | 21 October 2024 | Technology and Innovation Management |
| **3 Mon** | **28 October 2024** | **Projects** |
| **4 Mon** | **4 November 2024** | **Projects** |
| 5 Mon | 11 November 2024 | Manufacturing Systems Engineering (MSE)/Robot Lab |
| 6 Mon | 18 November 2024 | Robot Lab |
| 7 Mon | 25 November 2024 | Data and Decision Science |
| 8 Mon | 2 December 2024 | Advanced Operations Management |
| | | **Michaelmas Full term ends Friday 6 December 2024** |
| 9 Mon | 9 December 2024 | Robot Lab |
| | | **Lent Full term starts Tuesday 21 January 2025** |
| 0 Mon | 20 January 2025 | Production Technologies and Materials |
| 1 Mon | 27 January 2025 | Production Technologies and Materials |
| **2 Mon** | **3 February 2025** | **Projects** |
| **3 Mon** | **10 February 2025** | **Projects** |
| 4 Mon | 17 February 2025 | Sustainable Manufacturing |
| 5 Mon | 24 February 2025 | Leadership and Managing People |
| **6 Mon** | **3 March 2025** | **Projects** |
| **7 Mon** | **10 March 2025** | **Projects** |
| **8 Mon** | **17 March 2025** | **Long Project planning** |
| | | **Lent Full term ends Friday 21 March 2025** |
| | | **Easter Full term starts Tuesday 29 April 2025** |
| 0 Tue | 29 & 30 April 2025 (TBC) | Examinations |
| **1 Mon** | **5 May – 13 June 2025** | **Projects – 6 weeks** |
| 7 Mon | 16 June 2025 | Cambridge based |
| | | **Easter Full term ends Friday 20 June 2025** |

## Industrial Project Report Hand-In Dates 2024-2025

| Project Period | Latest time for delivery to MET Office | Last Date for Supervision with Project Supervisor | Date Corrected Report due into MET Office |
|---|---|---|---|
| **3-day project**<br>9 – 11 October | **Time: 8.45**<br>**Date: Monday 14 October** | Friday 18 October | Time: 8.45<br>Date: Wednesday 23 October |
| **2-week project**<br>28 October to 8 November | **Time: 08:45**<br>**Date: Monday**<br>**11 November** | Friday<br>15 November | Time: 08:45<br>Date: Wednesday<br>20 November |
| **4-week project**<br>3 February to 14 February<br>3 March to 14 March | **Time: 08:45**<br>**Date: Monday**<br>**17 March** | Friday<br>21 March | Time: 08:45<br>Date: Wednesday<br>26 March |
| **6-week project**<br>5 May to 13 June | **Time: 08:45**<br>**Date: Monday**<br>**16 June** | Friday<br>20 June | Time: 08:45<br>Date: **Monday**<br>**23 June** |

## Project, Coursework & Examination Credit for Part IIB of MET

*From the Secretary of the Faculty Board of Engineering*
The Examiners for Part IIB of the Manufacturing Engineering Tripos in 2024 will take account of work produced by candidates. The Faculty Board have determined that this shall consist of work with the requirements and total marks available set out below.

| | |
|---|---|
| 300 marks divided as follows: | |
| Manufacturing systems and robot lab | 55 marks |
| Industrial Projects | 245 marks |

| | |
|---|---|
| 300 marks in total are available for the examination papers: | |
| Two written papers, each marked out of 100 | 200 marks |
| Teaching modules, combined mark | 100 marks |

Some questions in the written papers may be based on written material provided by the examiners in advance; such material will be included as part of the examination paper and candidates may not bring any papers into the examination. Some of the teaching modules may be assessed through written examinations or other forms of assessment or a combination thereof as described in the MET IIB student handbook.

Students are expected to undertake all the coursework as specified above.
Students should refer to the MET Extensions & Penalty policy, which is included in the MET student handbook.
Work submitted for marking must be that of the student who submits it, as defined in the plagiarism, cooperating and cheating guidelines.

**Additional Notes:**

| *Industrial Project marks* | |
|---|---|
| Michaelmas term interim deliverables (2-week) | 45 marks |
| Lent term interim deliverables (4-week) | 80 marks |
| Easter term final deliverables (6-week) | 120 marks |
| **Total** | **245 marks** |

| *Teaching Module Assessments marks* | |
|---|---|
| Production Technologies and Materials | 22 marks |
| Sustainable Manufacturing | 13 marks |
| Data and Decision Science | 13 marks |
| Technology and Innovation Management | 13 marks |
| Strategy and Marketing | 13 marks |
| Leadership and Managing People | 13 marks |
| Advance Operations Management | 13 marks |
| **Total** | **100 marks** |

*Distinction, Merit, Pass and Fail*
*"Candidates who achieve a first-class standard in both examination and coursework credit will be awarded a Distinction. Candidates who have not obtained a Distinction but achieve at least a II.1 standard in both elements will be awarded a Merit.* ***The pass standard for the award of the MEng degree will require at least a II.2 standard in both elements."***

## Module Specifications and Timetables

### Introduction

The MET IIB taught modules mark a significant change from the traditional academic undergraduate programme of lectures, to a more professional 'real world' approach of intensive courses lasting from a few days up to two and half weeks.

### Aims

The aims of the taught modules are to:

1. present new teaching material and concepts, building on the fundamentals of manufacturing presented in MET IIA;
2. demonstrate the challenges of applying concepts to different company situations;
3. demonstrate that 'real world' situations are complex, requiring decisions based on incomplete data, and that in any given situation there is rarely an obvious or correct way forward;
4. enable students to practice critical group skills of team-working, discussion, influence, persuasion, consensus building, decision making and presentation.

### Style

Each module contains a variety of activities designed to encourage discussion and active participation. These include presentations from lecturers and visiting speakers, industrial visits, class discussions, exercises, group activities and case studies.

### Attendance

The nature of the modules means full attendance throughout is expected: the taught material is not readily available in textbooks and much of the learning comes from class and small group discussion. The assessment and examinations assume full attendance, and full participation in the group discussions, exercises and cases.

Students are advised to keep clear and well indexed notes of all module activities.

**Students should notify the IfM Teaching Office as soon as possible if they know they will be unable to attend any of the teaching sessions.**

### Assessment

Most modules have an end of module assessment, normally in the form of a short written examination or report. The module assessments form part of the overall assessment for the year, as shown earlier in the section on: "Project, Coursework & Examination Credit for Part IIB of MET". **Students should carefully note the assessment completion/submission times for each module** as provided by the module leader during each module introduction session**.**

### Module Specifications

Detailed modules specifications are given in the following pages. Each specification includes module learning outcomes, draft module timetables, session contents and learning outcomes, and form of assessment.

## MET-IIB-1: Induction Module (Including Enterprise, Globalisation and Policy)

Module Leader: Dr Letizia Mortara

Other IfM staff: Prof Ajith Parlikad, Dr Sebastian Pattinson, Prof Frank Tietze
Dr David Leal-Ayala, Dr Jennifer Castaneda-Navarrete, Philip Holt

Dates: Monday 7 October 2024 – Friday 11 October 2024

Location: IfM

Assessment: Enterprise, Globalisation and Policy lectures form part of the examinable content for the end of year exam (Paper 2).

**Module Learning Outcomes**

By the end of the module students will:

1. Understand the structure of MET IIB and how industrial projects work, learning approaches, key dates, assessment methods, expectations and responsibilities.
2. Appreciate the range of possible methods available when undertaking research to answer different types of questions, particular during industrial projects.
3. Be aware of the applied research skills and team-based project management skills required in an industrial context.
4. Understand that manufacturing is complex and must adapt to a complex, uncertain and dynamic environment.
5. Explain how companies do and might respond to these changes and subsequent industrial transformations.
6. Understand how and why governments are responding to help companies navigate the complexity and operate in an uncertain and changing environment through industrial and innovation policies.

| | | |
|---|---|---|
| **Links to other parts of MET IIB** | For Induction | Specific relevance to approaches to managing Industrial Projects |
| | For EGP | Provides broad context for all MET IIB modules |
| **Links to MET IIA** | For Induction | Differentiation of BA -> MEng approaches |
| | For EGP | Builds on foundations of 3P9, 3P10 |

**Induction Module (Including Enterprise, Globalisation and Policy (EGP))** *This timetable may be subject to changes*

| Time | Monday 7 October | Tuesday 8 October | Wed 9 October | Thurs 10 October | Fri 11 October |
|---|---|---|---|---|---|
| 0900-1030 | **Induction:** Introduction, How to succeed on MET IIB, MET IIB Structure, timetable and key dates. *Letizia Mortara, Shane Strawson, Ajith Parlikad/Sebastian Pattinson* | **EGP:** Complex and changing industrial landscape *David Leal-Ayala* | Industrial Projects | | |
| | Break | | | | |
| 1100-1230 | **Induction:** Introduction to MET IIB Industrial Projects *Frank Tietze* | **EGP:** How do firms and governments respond to the changing landscape? *David Leal-Ayala* | Industrial Projects | | |
| | Lunch | | | | |
| 1330-1500 | **Induction:** Mapping tools for industrial projects *Philip Holt* | **EGP:** How policy works? From agenda setting to evaluation *Jennifer Castaneda-Navarrete* | Industrial Projects | | |
| | Break | | | | |
| 1530-1630 | **Induction:** Essential MET IIB skills *Frank Tietze* | Induction Project briefings from supervisors (if not agreed at another time)<br><br>Travel to Induction Project companies | Industrial Projects | | |

**Induction – Syllabus and Learning Outcomes**

| Syllabus | Learning Outcomes |
|---|---|
| How to succeed at MET IIB | To understand the learning aims and approach of MET IIB, and how it differs from MET IIA.<br>Appreciation of the differences between MEng and BA-level learning. |
| Structure, timetable and key dates | To understand the structure of MET IIB, key dates, assessment methods, expectations and responsibilities. |
| Essential MET IIB Skills | To understand some major challenges when doing research and conducting industrial projects to answer different types of questions or rather solve certain problems.<br>To appreciate the relative merits and weaknesses of different methods.<br>To understand why certain conventions are helpful to create projects with impact.<br>To know where to find more information on using different methods.<br>To understand the importance of evidence-gathering for industrial projects, and how to apply different methods in an industrial project context. |
| Introduction to industrial projects in MET IIB, and some techniques methods that can be used in such projects. | To understand the role of industrial projects within MET IIB.<br>To be aware of a range of possible mapping techniques that can be used for industrial projects; to have basic knowledge of the relative merits and weaknesses of each. |
| Complex and changing industrial landscape | Understanding that manufacturing is complex and must adapt to a complex, uncertain and dynamic environment. |
| How do companies and governments respond to the changing landscape | Understand how companies do, and might, respond to these changes and subsequent industrial transformations.<br>Recognition of the complexities and trade-offs that companies must deal with when selecting and implementing new strategies.<br>Understand how and why governments are responding to help companies navigate the complexity and operate in an uncertain and changing environment through industrial and innovation policies.<br>Recognition of the complexities and trade-offs that are a feature of policy implementation. |

| | |
|---|---|
| Industrial Projects | To be aware of the key functions in a typical manufacturing organisation, and the connections between them.<br>To experience the MET IIB style industrial project work.<br>To have applied skills of evidence gathering, analysis, interpretation, collation and presentation.<br>To have applied the interpersonal and project management skills necessary to work as part of a team within an industrial context and specific time-constrained objective. |

**Reading list:**

Module resources given on Moodle.

## MET-IIB-2: Strategy and Marketing

Module leader: Prof Chander Velu

Other IfM staff: Dr Mark (Mohamed) Khater, Simon Pattinson

Dates: Monday 14 October 2024 – Friday 18 October 2024

Location: IfM

Assessment: Strategy and Marketing lectures form part of the examinable content for the end of year exam (Paper 2).

End of module case study written analysis. Electronic submission via Moodle online submissions.

Submission Deadline: Monday 21 October 08:45 hr. BST

**Module Learning Outcomes**

On completion of the module students should be able to:

- Describe and apply appropriate processes and frameworks for the development of strategy and marketing in a business.
- Describe the stages in the development of marketing and strategy as a function, and apply marketing and strategy techniques and frameworks at business unit and product levels.
- Understand the implications of digital technology adoption and the associated business development opportunities and challenges.
- Demonstrate knowledge and understanding of the role of product management, and its implementation in different business contexts.

| | | |
|---|---|---|
| **Links to other parts of MET IIB** | Sustainable Manufacturing Module | This module introduces the strategy, capabilities and business model elements that later in the Sustainable Manufacturing Module are further explained through a variety of case studies from the service and circular economy perspective. |
| | Leadership and Managing People | The strategy and marketing module introduce the elements of corporate and operations strategy, these are complemented by the leadership vision discussed in the Leadership and Managing People Module. |

| | | |
|---|---|---|
| | Technology and Innovation Management | Links to the type and innovation and the implications for business and operations' strategy and marketing. |
| | Data and Decision Science | This module links to the data and decision science module, particularly in the way that certain simulations and optimization outputs could influence the operations strategy of businesses. |
| | Industry projects (2/4/6 weeks) | This module provides opportunities to apply the marketing and strategy tools such as competitor's analysis, market research and business strategies. |
| **Links to MET IIA** | 3P9 | The Strategy and Marketing module has some complementary elements with 3P9. 3P9 introduced the concepts of business model canvas, the value propositions, resources, capabilities and competitive criteria. These are further expanded in this module in the marketing and strategy module. |
| | Industry visits | The elements of marking for product design of this Strategy and Marketing Module are complemented by the MET IIA industry visits. |

**Strategy and Marketing -** *This is a draft timetable and may be subject to changes*

| Time | Monday 14 Oct | Tuesday 15 Oct | Wednesday 16 Oct | Thursday 17 Oct | Friday 18 Oct |
|---|---|---|---|---|---|
| 0900–1030 | **Intro 2-Week Projects**<br>Frank Tietze + supervisors<br><br>**Intro to the Module**<br>Chander Velu | **Digital Technology and Transformation**<br><br>Chander Velu | **Ecosystems in Strategic Planning**<br><br>Florian Urmetzer | **Operations Strategy** - Resource/competency-based approach. Corporate Strategy & Operations Strategy<br>Mark Khater | **Operations Strategy** Cont.<br><br>Mark Khater |
| | Break | | | | |
| 1100–1230 | **Marketing**<br>Intended Strategy Business Planning<br><br>Simon Pattinson | **Digital Technology and Transformation**<br><br>Chander Velu | **Ecosystems in Strategic Planning**<br><br>Florian Urmetzer | **Operations Strategy** - Resource/competency-based approach. Corporate Strategy & Operations Strategy<br>Mark Khater | **Operations Strategy** Cont.<br><br>Mark Khater |
| | Lunch | | | | |
| 1330–1500 | **Marketing**<br>Product/Market lifecycles<br><br>Simon Pattinson | **Digital Transformation in the Energies and Utilities Sector**<br>**(Time : 1400-1600)**<br>**Rich Hampshire**<br>VP Digital Utilities, CGI | **Marketing of Robotics Surgery Product**<br><br>**(Time : 1400-1530)**<br>**Emma McCarthy**<br>Product Lead - Surgical Devices, CMR Surgical | **Operations Strategy** - Resource/competency-based approach. Corporate Strategy & Operations Strategy<br>Mark Khater | *Assessment case study preparation* |
| | Break | | | | |
| 1530–1700 | **Product Management**<br><br>**Chris O'Connor**<br>CEO Techcomp Europe | Free | Free | **Operations Strategy** Cont.<br><br>Mark Khater | **Module Assessment Submission Date:**<br><br>*21 October 2024, 08:45 hr BST* |

**Strategy and Marketing: Syllabus and session learning outcomes**

| Syllabus | Session learning outcomes |
|---|---|
| **The Nature and Role of Marketing**<br>The development of marketing as a business function<br>Consumer and B2B markets<br>The role of marketing at corporate, business unit, and product levels<br>The marketing process – internal and external analysis | Describe the historical development of marketing as a business function.<br><br>Discuss marketing as a socio-economic process. Marketing as a business philosophy: the marketing concept, market orientation, why is marketing important to firms? Marketing as a business function. Marketing mix and the marketing environment. |
| **Marketing Objectives and Strategy**<br>Creating strategic advantage – how, direction, method<br>Different market strategies<br>Developing a marketing plan – 4Ps<br>- Segmentation, targeting, positioning | Describe the customer value proposition: The components of the marketing plan; conducting marketing research and forecasting demand.<br><br>Describe consumer behaviour: stages in the consumer and organisational buying process; variations in the buying process. Segmentation: how to identify segments of customers within markets. Targeting: identifying segments to target. Positioning: achieving a superior position in the minds of customers relative to competitors. |
| **Product Management**<br>Example of the core processes used in product management in firms:<br>- integration across the supply chain – market research, selection, development, manufacture and sales<br>- relationship between R&D and marketing<br>- focus on product life cycle management | Describe the role of product management and the core processes used.<br><br>Describe the product life cycle: its stages and determinants. Managing demand, the product mix and the marketing mix over the life cycle. New product development: strategies and risks. |
| **Digital Technology and Transformation**<br>This section examines new digital technologies (including artificial intelligence) and their potential to reshape industries. The chapter also highlights an early-stage emerging technology, quantum technology, as it promises major business model innovation opportunities, as well as challenges, to provide benefits to society that | Describe the economics of digital technologies<br>Outline the challenges to digital transformation<br>Describe the implications of quantum technologies on business model innovation |

| | |
|---|---|
| would not be possible with existing digital technologies | |
| **Ecosystems in Strategic Planning**<br>Today's world is complex and interconnected. Individual organisations are unlikely to possess all the resources and capabilities required to meet the demands of their end-customers. Firms must draw resources from other firms and successfully integrate them into their offering. | Describe how businesses need to attract the right partners, suppliers and form alliances to enable them to share resources in co-operative networks.<br>Demonstrate an understanding and strategic use of an organisation's capability and resources. |
| **Operations and Manufacturing Strategy**<br>Strategy frameworks<br>The importance of strategy alignment<br>Competitive criteria<br>Structural and infrastructural factors | Discuss and apply the stages in the development of a business linked operations and manufacturing strategy |

**Reading List**


Bourne, M. Wilcox, Neely, A., and Platts K., (2000); "Designing, Implementing and Updating Performance Measurement System"; *International Journal of Operations and Production Management*, Vol. 20(7): 754-771.

Eccles, R. (1991), "The performance measurement manifesto", *Harvard Business Review*, January

Gray, D., Micheli, P. and Pavlov, An. (2014). *Measurement Madness: Recognizing and Avoiding the Pitfalls of Performance Measurement,* John Wiley & Sons.

Kaplan R. S. and Norton D. P. (1992); "The balance scorecard – measures that drive success'; *Harvard Business Review*; Jan-Feb

Kaplan, R.S. and Norton, D.P. (1996), "Linking the Balanced Scorecard to Strategy (Reprinted From the Balanced Scorecard)", *California Management Review*, Vol. 39, No. 1, pp. 53- 79.

Kotler, P., Keller, K.L. & Brady, M. (2012). *Marketing Management,* Prentice-Hall/Pearson Education, 2nd edition.

Kumar, N. (2004). *Marketing as Strategy: Understanding the CEO's agenda for driving Innovation and Growth*, Harvard Business School Press.

Lannon, Judy and Baskins, Merry (2009). *A Master Class in Brand Planning: The Timeless Works of Stephen King,* Wiley.

Mayer-Schonberger, V. and Cukier, K. (2013). *Big Data: A Revolution That Will Transform How We Live, Work and Think*, John Murray.

Mills, J. F., Platts, K. W., Neely, A. D., Richards, A. H., & Bourne, M. C. S. (2002). *Creating a Winning Business Formula*: Cambridge University Press. ISBN: 0-521-75029-6.

Mills, J. F., Platts, K. W., Bourne, M. C. S., & Richards, A. H. (2002). *Competing through Competences*: Cambridge University Press. ISBN: 0-521-75030-X.

Neely, A. D., Bourne, M. C. S., Mills, J. F., Platts, K. W., & Richards, A. H. (2002). *Getting the Measure of your Business*: Cambridge University Press. ISBN: 0-521-75031-8.

Siegel, E. (2013*). Predictive Analytics: the Power to Predict Who Will Click, Buy, Lie, or Die*, John Wiley & Sons.

Velu, C. (2024). *Business Model Innovation: A Blueprint for Strategic Change*, Cambridge University Press.

**Online Resources**

Marketing

Narver, J and S. Slater, (1990), The effect of a marketing orientation on business profitability, *Journal of Marketing,* 54(4), 20-35

Kohli, A. K, and B. J Jaworski. 1990. Market orientation: the construct, research propositions, and managerial implications. *Journal of Marketing* 54 (2) 1–18.

***VIDEO. The Marketing Mix - The 4 P's of Marketing. https://www.youtube.com/watch?v=hHtJwTU9kg8

Strategy

Mintzberg, H. (1985). Of Strategies: Deliberate or emergence, *Strategic Management Journal*, 6, 257-272

Pascale, R.T. (1984). Perspective on strategy: The real story behind Honda's success, *California Management Review*, 26(3), 47-72

*** VIDEO – THE ESSENTIALS: Porter M. (2015). What is strategy? The summary. https://www.youtube.com/watch?v=3Hd88eBgkw0

*** VIDEO – Porter M. (2008). The five competitive forces that shape strategy. https://www.youtube.com/watch?v=mYF2_FBCvXw

Wheelwright S. and Hayes R. (1985). Competing through manufacturing. *Harvard Business Review*. Jan.

Hayes R and Pisano G (1994). *Beyond world class: the new manufacturing strategy*. 77-86.

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*Digital Technologies and Ecosystems*

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*Raisch, S. and Krakowski, S. (2021). Artificial Intelligence and Management: The Automation-Augmentation Paradox. Academy of Management Review 46(1): 192–210.*

*Velu, C. (2020). Business Model Cohesiveness Scorecard: Implications of Digitization for Business Model Innovation. In: S. Nambisan, K. Lyytinen, and Y, Yoo (eds.), Handbook of Digital Innovation. UK: Edward Elgar.*

*Velu, C., Pooya, G., and Dalzell-Payne, P. (2019). Targeting the Full Value of Digital Disruption. Cambridge and IBM Report.*

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## MET-IIB-3: Technology and Innovation Management

| | |
|---|---|
| Module leader: | Prof Frank Tietze |
| IfM staff: | Prof Tim Minshall, Dr Letizia Mortara, Dr Clive Kerr, Dr Rob Phaal, Dr Thomas Bohné |
| Dates: | Monday 21 October 2024 – Friday 25 October 2024 |
| Location: | IfM |
| Assessment: | Technology and Innovation Management lectures form part of the examinable content for the end of year exam (Paper 2). Attendance and participation in the City Car simulation. Guest lecture on Friday.<br>End of module assessment. Electronic submission via Moodle online submissions. Submission Deadline: Monday 28 October 08:45 hr. |

**Module learning outcomes:** On completion of this module, students should be able to:

Demonstrate knowledge and understanding of:

- key technology, innovation and intellectual property management concepts and frameworks;
- practically relevant technology and innovation management tools and techniques;
- details of innovation types and innovation processes;
- the management of new product introduction (NPI) and open innovation;
- and the context of technology and innovation management.

Demonstrate the ability to:

- evaluate technologies and innovations, and select appropriate approaches to manage them;
- apply tools and techniques to real business situations, cases and simulations;
- identify and critically analyse technology and innovation management issues;
- understand team challenges when developing new product innovations and
- appreciate the strategic relevance of intellectual property.

The module applies a set of complementary teaching and learning techniques, a set of small-group exercises (e.g. in-class case study, strategy development using roadmapping), a one-day group simulation exercise and a high-profile guest talk by a former MET student now in a leading management position.

| | | |
|---|---|---|
| **Links to other parts of MET IIB** | | Strategy and Marketing module |
| | | Leadership and people module |
| **Links to MET IIA** | | (3P9) Industrial Economics, Strategy and Governance (Service/ BM innovation, strategy and strategic planning, firm boundaries, competition) |
| | | (3P7) Managing Business and People (Entrepreneurship, change management, trends, competition) |
| | | (3P10) Contemporary Issues in Manufacturing |
| | | Other links: Design project, (3P6) Organisational behaviour |

**Technology and Innovation Management -** *This is a draft timetable and may be subject to changes*

| | **Monday 21 October** | **Tuesday 22 October** | **Wednesday 23 October** | **Thursday 24 October** | **Friday 25 October** |
|---|---|---|---|---|---|
| **0900-1045** | Introduction to MET IIB long projects<br><br>Module introduction<br>*Frank Tietze* | Strategic technology management<br>*Rob Phaal* | Technology exploitation and protection<br>*Frank Tietze* | City car simulation<br>*Thomas Bohné + team* | From Racetrack to road and off again – commercializing technology<br>*James Colgate (WAE)* |
| Coffee | | | | | |
| **1100-1230** | Evolution of industries, technologies and markets<br>*Tim Minshall* | Technology roadmapping<br>*Rob Phaal* and<br>*David Thomas*<br>*(Global Innovation Capability Director)* | Open innovation<br>*Tim Minshall* | City car simulation<br>*Thomas Bohné + team* | Module review (30min)<br><br>Assessment preparation |
| Lunch | | | | | |
| **1330-1500** | NPI and Innovation<br>*Letizia Mortara* | Technology identification and acquisition<br>*Letizia Mortara* | Assessment preparation | City car simulation (until about 14:30)<br>Assessment preparation | Assessment preparation |
| Tea | | | | | |
| **1515-1700** | 15:30 start:<br>ISAEP model (30min)<br>*Tim Minshall*<br>Assessment preparation | Technology selection<br>*Clive Kerr* | Assessment preparation | Assessment preparation | **Module assessment Submission date: Monday 28 October Time: 08:45** |

**Technology and Innovation Management - Syllabus and session learning outcomes**

| Syllabus | Learning outcomes |
|---|---|
| **Introduction**<br>Overview of the module<br>Philips case study<br>Introduction to technology management frameworks and models | Understand the aims, objectives and scope of the module<br>Describe the typical technology management challenges that technology intensive firms face<br>Recognise the importance of technology management tools and frameworks in addressing these challenges |
| **Evolution of industries, technologies and markets**<br>The challenge of disruptive innovations | Appreciate the dynamic nature of technologies, industries and markets, and the challenges this presents to managers<br>Understand the particular challenges of disruptive innovations |
| **Technology management processes**<br>(Identification, Selection, Acquisition, Exploitation, Protection (ISAEP)) | List some of the typical activities that a technology intensive firm can use in each of the ISAEP processes |
| **Technology protection/ exploitation** | Appreciate the importance of intellectual property, its management and strategy to protect technologies and maximize value generation from innovations and novel technologies<br>To understand the complexities of IP in the development, exploitation (diffusion and commercialisation) of innovative technologies |
| **Strategic Technology Management**<br>**Technology Road-mapping** | Appreciate that all technology management decisions need to be considered in the wider strategic context<br>Describe and apply the tools and techniques for supporting the strategic management of technology<br>Understand what it takes to create a technology roadmap |
| **NPI, innovation and open innovation**<br>Implementation challenges<br>Different innovation management approaches and different types of innovation projects. | Understand what is meant by innovation processes and 'open innovation' processes and how it contrasts with 'closed' approaches. Approaches for managing innovation along the NPI process. Challenges faced by firms seeking to implement open innovation, and how these challenges can be addressed |
| **Technology acquisition** | Understand why/how companies define the scope of their activities, and the link to MvB<br>Apply MvB strategy formulation and decision support methods in technology intensive |

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| | contexts. Aspects of identifying novel technologies.<br>Develop assessment criteria for the acquisition of early stage technologies |
| **Technology Identification (intelligence)** | Describe the importance and challenges firms face in monitoring threats and opportunities from new technologies<br>Understand some of the basic approaches for monitoring the changing technology landscape |
| **Technology selection** | To understand the challenges and approaches for selecting technologies that are relevant for ensuring companies continue to innovate and maintain competitive advantage |
| **City car simulation** | To experience in a group setting the challenges, technical and managerial, associated with the development and introduction of novel/innovative products |
| **Industry guest speaker** | Providing an industry perspective on key concepts discussed during the previous lectures on technology and innovation management |
| **Module assessment** | Demonstrate understanding of key module concepts |

**Reading list**


Aristodemou, L., F. Tietze and M. Shaw (2020). Stage Gate Decision making: a scoping review of Technology Strategic Selection Criteria for Early Stage Projects. IEEE Engineering Management Review 48(2): 118-135.

Blümel JH, Tietze F, Phaal R. Formulating IP strategies for service-intense business models: A roadmapping-based approach. World Patent Information. 2022;70.

Christensen, C. M. (1997). The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Cambridge MA, Harvard Business School Press, ISBN: 0875845851.

Goffin, K. and R. F. Mitchell (2017). Innovation Management: Effective strategy and implementation Palgrave.

Govindarajan, V. and C. Trimble (2010). The other side of innovation: Solving the execution challenge, Harvard Business Review Press.

Gregory, M. J. (1995). Technology management: A process approach. Proceedings of the Institute of Mechanical Engineers 209: 347-356.

Kerr, C. I. V., L. Mortara, R. Phaal and D. R. Probert (2006). A Conceptual Model for Technology Intelligence. International Journal of Technology Intelligence and Planning 2(1): 73-93.

Moore, G. (1991). Crossing the chasm. New York, HarperBusiness.

Probert, D. (1997). Developing A Make Or Buy Strategy For Manufacturing Business, Institution Of Electrical Engineers

Tietze, F. (2023). The patenting versus publishing dilemma. Nature Communications, 14(1), 1562.

Vimalnath P, Tietze F, Jain A, Gurtoo A, Eppinger E, Elsen M. (2022) Intellectual property strategies for green innovations - An analysis of the European Inventor Awards. Journal of Cleaner Production. (377)

For many of the subjects covered, the Centre for Technology Management's website provides a rich source of readings, e.g.

**Technology Roadmapping**
http://www.ifm.eng.cam.ac.uk/roadmapping/

**Technology Intelligence**
http://www.ifm.eng.cam.ac.uk/research/ctm/techintelligence/

**Open Innovation**

http://www.ifm.eng.cam.ac.uk/research/ctm/openinnovation/

**Intellectual Property Management and Strategy**
www.ifm.eng.cam.ac.uk/iipm

Various research papers from the Centre for Technology Management are available in the centre's working paper series:

www.ifm.eng.cam.ac.uk/research/ctm/ctmpublications/ctmworkingpapers/

## MET-IIB-4: Manufacturing Systems Engineering / Robot Lab

The module is in two parts: a taught component, followed by an extended practical session.

Module Leader: Alan Thorne, Prof. Duncan McFarlane

Other IfM staff: Simon Sennitt, Chris Jennings, Dr Zhengyang Ling

Dates: Taught Component: Monday 11 – Friday 15 November 2024
Practical Component: Monday 18 – Friday 22 November 2024;
Monday 9 – Friday 13 December 2024

Location: Taught Component: Face to Face
Practical Component will be a mix of:

- Face to Face
- Timed lab slots in the Automation Laboratory, Alan Reece Building. (Full details of lab access times is provided in lab handbook)
- Assessment: The module will be assessed entirely on the practical systems build. The assessment will be based on scheduled interim staff appraisals/technical mark (60%), Technical Report (10%), Final Presentation (10%), Final Integrated Solution & Demonstration (20%).

Electronic submission via Moodle Submissions

Submission Deadline for report: Mon 13 January 2025 - 08:45 GMT

Manufacturing Systems Engineering lectures form part of the examinable content for the end of year exam (Paper 1).

Attendance: Due to the nature of the module, students must have permission before missing the practical component. Absence from practical sessions will result in lower mark being awarded for the module.

**Module Learnings Outcomes**

- Primary: To provide students with the ability to design and build automated manufacturing systems.
- Subsidiary:
    - To provide students with an awareness of the state of the art in certain elements of automated manufacturing technology.
    - To provide experiential learning of managing a complex project, including managing self, managing others and managing time.

**Background**

The design of manufacturing systems is a key integrating activity for manufacturing engineers and managers. Although manufacturing transformation processes are diverse, the principles involved in building systems are transferable. One needs to define the requirements and plan upfront, to understand the detail of the processes involved, to foresee potential failure modes and plan recovery etc. This module aims to teach students these principles through a mixture of didactic teaching and experiential learning. It is based around the physical building of an automated machining/assembly system, supported by teaching sessions on planning systems integration, and on elements of automation.

A major theme running throughout the entire module is that of 'learning'. In today's turbulent business environment, companies need to recognise that static solutions are unlikely to provide competitive advantage for long. Arie de Geus, (ex-Planning director for Shell), is quoted as saying that the only sustainable source of competitive advantage is being able to learn faster than the competition. Thus knowing 'how to learn' is an essential skill for engineers and managers, and the activities in the module are devised to encourage students to 'learn how to learn'

**Learning objectives**

On completion of this module students should:

1. Know and understand the stages of planning and implementing integrated manufacturing systems, including the major pitfalls and how to avoid them.
2. Be able to write a simple functional specification for an automated system.
3. Know the state of the art in CNC machining, robotics, PLC control, and factory communications technology.
4. Understand the basic principles of tool and fixture design for automated operations and be able to design simple fixtures and robot end effectors.
5. Know the different types of sensor used in automation, and understand the importance of their correct application in designing robust systems.
6. Understand the basic principle of machine and cell control.
7. Be able to plan and carry out an assigned automation task and to integrate this with other complementary tasks to deliver a fully functioning system. This involves developing an understanding, and practical experience of:
    - managing projects
    - managing self
    - learning how to learn
    - problem solving
    - communications

**Module structure and content**

The module will be split into two parts: a taught component, followed by an extended practical session:

**The taught aspects** of the module are designed to provide the theoretical background and underpinning to the practical work. These will include sessions on planning automation, on the various technologies used in automated systems: CAM/CNC, programmable logic controllers, robotics, sensing, fixture design; and on controlling an automated cell.

**The practical aspect** of the module will enable an automation system to be developed within the automation lab. This will be through the configuration and programming of existing automation equipment within the lab (Robots, Conveyors & Machine Tools). Additional bespoke automation components required such as (Fixtures, Feeders & End Effectors…) will also be designed and developed. The overall control of the automation system will be performed by an industrial programmable logic controller (PLC).

The practical exercise is intended to give students hands-on experience of the design and construction of automated systems, and alert them to the types of problem that arise. A major part of this is experiential learning of the softer skills of project management: managing one's self, communicating, group problem solving and learning.

More detail on the practical aspect is given in a separate booklet which will be issued at the start of the MSE module. If at any point you have questions or concerns around these procedures please talk to a member of staff.

**MSE/Robot Lab – Week 1** *This is a draft timetable and may be subject to changes*

| | | **Morning** | | | **Afternoon** | |
|---|---|---|---|---|---|---|
| Monday<br>11 November | **09:00**<br><br>**09:15-**<br>**10:45**<br>**11:15-**<br>**13:00** | Introduction<br><br>Planning Systems Integration<br>(Break at 10:00)<br>Boeing's Digital Journey<br>(Digital Systems – ISA 95) | Alan Thorne /<br>Duncan McFarlane<br><br>Tim Mead<br>Innomech Ltd.<br>Gary Hilton<br>Boeing (UK) | **14:00-**<br>**15:00**<br>**15:00-**<br>**15:30**<br>**15:30-**<br>**17:00** | Introduction to Robot Lab Exercise<br><br>Lab. Safety Talk – H&S questionnaires<br><br>Robot Lab Planning, definition of groups | Alan Thorne /<br>Simon Sennitt<br><br><br><br>Alan Thorne /<br>student teams |
| Tuesday<br>7 November | **09:00-**<br>**9:45**<br>**10:00-**<br>**12:30** | Introduction to Programmable Logic<br>Controllers (PLC's)<br>Breakout Activity [2 Groups ½ of MET]<br>Exercise PLC programming (Grp. 1)<br>PLC Technologies/Case Studies (Grp. 2) | Barry Graham<br>Omron<br>Wayne Corp<br>Omron<br>Barry Graham | **14:00-**<br>**16:00** | Exercise PLC programming (Grp. 2)<br>PLC Technologies/Case Studies (Grp. 1)<br>Questions | Wayne Corp/<br>Barry Graham |
| Wednesday<br>8 November | **09:00-**<br>**10:45**<br><br>**11:00-**<br>**11:40**<br>**11:50-**<br>**13:00** | Integrated Manufacturing Systems: CNC<br>Machines Tools, FMS and Automated<br>Machining Systems<br>Automation Solutions:<br>Implementation Development Challenges | Mark Hall<br>Yamazki<br>Mazak (UK)<br>Dave Black<br>Joe McNamara<br>Jaguar Land<br>Rover | | **Free** | |
| Thursday<br>9 November | **09:00-**<br>**09:45-**<br>**10:30**<br>**11:00-**<br>**11:50**<br>**12:00-**<br>**13:00** | Sensors in Automation<br>Fixtures and End effectors<br><br>Cell control and System Test<br><br>Industrial IOT | Alan Thorne<br><br><br>Alan Thorne<br><br>Duncan McFarlane | **14:00-**<br>**14:45**<br>**14:45-**<br>**15:15**<br>**16:00-**<br>**17:30** | Low Cost Digital Solutions:<br>Digital Manufacturing on a Shoestring<br>Introduction to Low Cost Vision &<br>Monitoring Systems<br>Exercise – Low Cost Vision and<br>Monitoring solutions | Duncan McFarlane /<br>Anandarup Mukherjee<br>Zhengyang Ling<br><br>Zhengyang Ling |
| Friday<br>10 November | **09:00-**<br>**10:30**<br>**11:00-**<br>**13:00** | Warehouse Services / Automation<br><br><br>Pneumatic Systems in Automation | Micheal Lemut /<br>Micheal Codd<br>Knapp<br>Nick Watson /<br>Anna Ellis<br>SMC Pneumatics<br>UK) | **14:00-**<br>**15:15**<br>**15:45-**<br>**17:00** | Introduction to Robotics<br><br>Introduction to Off-line robot<br>programming / Lab | Alan Thorne<br><br>Alan Thorne |

**MSE/Robot Lab – Week 2** *This is a draft timetable and may be subject to changes*

| | | Morning | | | Afternoon | |
|---|---|---|---|---|---|---|
| Monday<br>18 November | **09:00-13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |
| Tuesday<br>19 November | **09:00-13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |
| Wednesday<br>20 November | **09:00-13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-17:00** | **ROBOT LAB** | |
| Thursday<br>21 November | **09:00-13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |
| Friday<br>22 November | **09:00-13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |

A coffee/tea break will be taken each day at around 11-00am, and 3-15pm.

**MSE/Robot Lab – Week 3** *This is a draft timetable and may be subject to changes*

| | | Morning | | | Afternoon | |
|---|---|---|---|---|---|---|
| Monday<br>9 December | **09:00-<br>13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-<br>17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |
| Tuesday<br>10 December | **09:00-<br>13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-<br>17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |
| Wednesday<br>11 December | **09:00-<br>13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-<br>17:00** | **ROBOT LAB** | |
| Thursday<br>12 December | **09:00-<br>13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-<br>17:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |
| Friday<br>13 December | **09:00-<br>13:00** | **ROBOT LAB** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling | **14:00-<br>16:00** | **Presentations / Wrap-up** | Alan Thorne<br>Duncan McFarlane<br>Chris Jennings<br>Simon Sennitt<br>Zhengyang Ling |

A coffee/tea break will be taken each day at around 11-00am, and 3-15pm.

**Manufacturing Systems Engineering - Syllabus and session learning outcomes**

**(Note <u>all lecturer</u> material within the MSE module is examinable)**

| Syllabus | Session learning outcomes |
|---|---|
| **Planning Systems Integration**<br>Managing large projects.<br>Stages of planning and implementation.<br>Functional specifications.<br>Typical problems with integration and how to avoid/solve them. | Know and understand the stages of planning and implementing integrated manufacturing systems, including the major pitfalls and how to avoid them.<br>Write a simple functional specification for an automated system.<br>Appreciate and be able to manage the effect of changes during design and implementation. |
| **Introduction to Robot Lab**<br>Aims of the practical sessions.<br>Description of the tasks.<br>Organisation and methods of working.<br>Risk assessment.<br>Health and safety considerations.<br>Methods of staff support.<br>Methods of assessment. | Understand the practical task, the methods of operation, and the methods of assessment to be used.<br><br>Carry out risk assessments, and to install and maintain safe working practices. |
| **CNC Machine Tools, FMS, Automated Machine Systems**<br>Types of CNC machine tool.<br>Benefits of multiple axis machines, esp 5,6 axis.<br>Types of tooling and sensing.<br>Automated methods of loading.<br>Minimally manned operation.<br>'Make complete in one'<br>Machine from solid vs forge/cast and machine. | Know the state of the art in CNC machining and Flexible Automated Manufacturing Systems.<br><br>Understand current industrial needs, practical applications and automated solutions.<br>Relate automated solutions to business needs. |
| **Introduction to Automation / Robotics**<br>What is Automation (Definitions)<br>Automation Benefits / Challenges<br><br>Types of robots.<br>Benefits of different axis configurations.<br>Types of end effector.<br>Sensing.<br>Software enhancements – soft float, force feedback etc.<br>Vision systems and robotics.<br>Multiple robot systems. | Definitions of Automation from Oxford dictionary and Automation Federation.<br>Understand the benefits that automation can provide as well as the challenges that need to be considered in implementing solutions.<br><br>Know the state of the art in robotics.<br>Understand current industrial needs, practical applications and automated solutions.<br>Relate automated solutions to business needs. |

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| **Sensors in automation**<br>Requirements for sensing in automated systems.<br>Types of sensors.<br>Connecting sensors into systems.<br>Benefits and limitations of different sensor types.<br>Sensor applications. | Know the different types of sensor used in automation.<br><br>Choose an appropriate sensor, and understand the importance of the correct application of sensors in designing robust systems.<br>Implement sensor technology into automated systems. |
| **Fixturing and end effectors**<br>Principles of fixture design.<br>Factors affecting accuracy and repeatability<br>Kinematic location.<br>Methods of clamping.<br>Sensor requirements for fixtures in unmanned operation. | Understand the basic principles of tool and fixture design for automated operations.<br>Design and build simple fixtures and robot end effectors. |
| **Cell control**<br>Different approaches to cell control.<br>Centralised and decentralised control systems.<br>Auto-ID technologies.<br>Monitoring and visualisation, SCADA systems. | Understand the basic principles of machine and cell control.<br><br>Specify a control architecture for a simple automated manufacturing cell.<br>Understand the need for, and how to deal with, mixed product production in automated cells. |
| **Programmable logic controllers**<br>PLC vs. PC for cell control.<br>Functionality of modern PLCs.<br>Methods of PLC programming: ladder logic; sequential function charts.<br>Communications and networks, deterministic versus non-deterministic;<br>Industrial networks, Devicenet, Ethernet, Profibus etc. | Know the state of the art in PLC control, and factory communications technology.<br>Be able to develop and test simple PLC programmes.<br><br>Understand the methods of linking PLCs into factory systems. |
| **Pneumatic Systems in Automation**<br>Overview of infrastructure components required to deliver pneumatic / vacuum solutions. (Compressors, Dryers, Storage, Regulation)<br>Overview of control and actuation components. (Valves, Regulators, Actuation Cylinders, Grippers, Suckers)<br>Basic component symbology and circuit layouts.<br>Transformational technologies supporting / impacting pneumatic solutions. | Understand what the key components are that would be required in implementing a pneumatic solution in an industrial environment.<br>Basic understanding of control and actuation components that would be required in the controlled operation of a fixture / robot end effector.<br><br>Use of standard pneumatic circuits and symbology to describe the operation of a pneumatic system. (Clamping components of a fixture) |

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|---|---|
| **Industrial IOT**<br>Overview of industrial IOT. What is IOT, where did it come from and how does it work with IT Systems. Examples of how different companies are implementing and benefiting from IOT; Flour, Unilever, Rolls Royce and Mazak. | Understand what IOT is and in what situations it can be useful to an organisation. |
| **Low Cost (Automation) Digital Solutions**<br>Overview of global digital manufacturing initiatives. Challenges that are faced by SME's in adopting these initiatives. Examples of low-cost digital solutions (Application Areas) that can provide benefits to SME's.<br><br>Overview of the Shoestring research project. Investigating how low-cost consumer technologies and software development environments can support SME's manufacturing needs. | Understand what digital manufacturing initiatives are being carried out around the world.<br><br>Examples of low-cost digital solutions (Application Areas) that can provide benefits to SME's.<br><br>Objectives of the Shoestring research project and the types of consumer electronics being introduced to the manufacturing applications. |

## MET-IIB-5: Data and Decision Science

Module Leader: Dr Timos Kipouros

Other IfM staff: Stefan Schoepf, Sara AlMahri, Dr Ge Zheng, Prof Ajith Parlikad

Dates: Monday 25 November – Friday 29 November 2024

Location: IfM

Assessment: Data and Decision Science lectures form part of the examinable content for the end of year exam (Paper 1)

Electronic submission via Moodle online submissions

Submission Deadline: Monday 16 December 2024 - 08:45 GMT

**Module Learning Outcomes** – on completion of the module students should be able to:

1. Appreciate the complex nature of business decision-making and develop a suitable approach to model decisions.
2. Understand, and apply, appropriately selected data analytics techniques for analysing industrial data to reveal insights for the business.
3. Understand, select and apply machine learning and artificial intelligence techniques to solve industrial problems.
4. Appreciate how advanced data analytics and decision-making is transforming industries.

| | | |
|---|---|---|
| **Links to other parts of MET IIB** | | Links to industrial problem settings and Industry 4.0 concepts discussed in Advanced Operations Management. |
| **Links to MET IIA** | | Advances concepts taught in 3P4 such as risk and variability in supply chains and factory operations. |

**Data and Decision Science** *This is a draft timetable and may be subject to changes*

| Time | Monday 25 Nov | Tuesday 26 Nov | Wednesday 27 Nov | Thursday 28 Nov | Friday 29 Nov |
|---|---|---|---|---|---|
| **0930-1030** | Introduction to module<br>Timos Kipouros<br>(Study Room) | Neural Networks<br>Stefan Schoepf,<br>Ge Zheng,<br>Sara AlMahri<br>(Study Room) | Introduction to Optimisation<br>Timos Kipouros<br>(LT) | Discrete Event Simulation<br>Ajith Parlikad<br>(Study Room) | Optimising business decisions – Practical session<br>Timos Kipouros<br>(LT) |
| Coffee | | | | | |
| **1100-1230** | Sampling<br>Practical<br>Timos Kipouros<br>(Study Room) | Neural Networks<br>Stefan Schoepf,<br>Ge Zheng,<br>Sara AlMahri<br>(Study Room) | Multi-objective Optimisation and Optimisation with Heuristics<br>Timos Kipouros<br>(LT) | Discrete Event Simulation<br>Ajith Parlikad<br>(Study Room) | Optimising business decisions – Practical session<br>Timos Kipouros<br>(LT) |
| Lunch | | | | | |
| **1330-1500** | Business analytics: Multiple Regression analysis<br>Timos Kipouros<br>(Study Room) | Decision Making Under Uncertainty<br>Ajith Parlikad<br>(Study Room) | Self-study/ Office hour<br>Timos Kipouros | Data mining<br>Ge Zheng<br>Sara AlMahri<br>(Study Room) | Self-study/ Office hour<br>Ajith Parlikad |
| **1500-1630** | | | | | **Module assessment Submission Date: Monday 16 December Time: 08:45 hr GMT** |

**Data and Decision Science - Session syllabus and learning outcomes**

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| **Introduction** | Appreciate the range of logical and structured applications of modern data analytics methods and their role in supporting decision making in business |
| **Sampling** | Explore the basics of sampling data and appreciate how sampling can be used through a hands-on case study. |
| **Regression analysis** | Learn to construct single and multiple regression models, and how to interpret model outputs |
| **Optimisation** | Learn how to formulate single and multi-objective optimisation problems<br>Understand the range of Heuristic and nature-inspired methods applied to optimization problems.<br>Learn how to structure and solve optimisation problems in operations management |
| **Neural networks** | Learn about the fundamentals of Neural Networks, what problems they are appropriate for, and practice using Neural Networks through a hands-on session. |
| **Discrete Event Simulation** | Understand the fundamentals of simulating a manufacturing operation<br>Learn how to use Arena to develop a simulation model and analyse the results |

**Reading List**


1. Hillier, F.S., *Introduction to Operations Research,* McGraw Hill.
2. Wisniewski, M. *Quantitative methods for decision makers*, Prentice Hall.
3. Russel and Norvig, *Artificial Intelligence: a modern approach*, Prentice Hall.


**Additional readings will be provided on Moodle.**

## MET-IIB-6: Advanced Operations Management

Module Leader: Prof Ajith Parlikad

Other IfM staff: Prof Alexandra Brintrup, Prof Duncan McFarlane, Dr Mukesh Kumar, Dr Mohamed Zaki, Dr Maharshi Dhada

Dates: Monday 2 December – Friday 6 December 2024

Location: IfM

Assessment: End-of-Module Assignment

Electronic submission will be via Moodle online submissions

Submission Deadline: 08:45am Monday 9th December

Advanced Operations Management lectures will form part of the examinable content for the end of year exams.

**Module Learning Outcomes** – on completion of the module students should be able to:

1. Understand the principles of and the practical challenges involved in industrial logistics and warehousing
2. Learn how to make decisions about routing of products and optimal location of warehouses
3. Identify and analyse the risks involved in the management of complex supply chains
4. Understand issues in supply chain coordination
5. Discuss the concept of servitization and the key differences between manufacturing and service operations.

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| **Links to other parts of MET IIB** | | Applies concepts of optimization and data analytics from the Data and Decision Science module to Operations Management |
| | | The lectures on servitization will have links to the material covered in the Strategy & Marketing Module |
| **Links to MET IIA** | | 3P5 – Maintenance Engineering; Facility Layout Planning; Lean Manufacturing |
| | | 3P4 – Supply chain management; Inventory Management |
| | | 3P2 – Statistical Process Control |

**Advanced Operations Management** *This is a draft timetable and may be subject to changes*

| Time | Monday 2 Dec | Tuesday 3 Dec | Wednesday 4 Dec | Thursday 5 Dec | Friday 6 Dec |
|---|---|---|---|---|---|
| **0915-1030** | Module Introduction<br>*Ajith Parlikad*<br>Industrial Logistics<br>*Maharshi Dhada* | Temporary logistics operations<br>*Duncan McFarlane* | Logistics in practice<br>*Industrial speakers (TBC)* | Supply chain risk and resilience<br>*Mukesh Kumar* | Services in Practice<br>*Industrial Speaker (TBC)* |
| Coffee | | | | | |
| **1045-1230** | Transportation & Warehouse Management<br>*Maharshi Dhada* | Quantitative approaches in Supply Chain Management<br>*Alexandra Brintrup* | Logistics in practice<br>*Industrial speakers (TBC)* | Supply chain risk and resilience<br>*Industrial speaker (TBC)* | The future of services with digital<br>*Mohamed Zaki* |
| Lunch | | | | | |
| **1330-1500** | Practical exercises on Transportation<br>*Maharshi Dhada* | Supply Chain Game<br>*Ajith Parlikad/ Maharshi Dhada* | Coursework Preparation | Introduction to Services and Service Design<br>*Mohamed Zaki* | Coursework Preparation |
| Break | | | | | |
| **1515-1700** | | Supply Chain Game<br>*Ajith Parlikad/ Maharshi Dhada* | Coursework Preparation | Customer service journey and business model innovation<br>*Mohamed Zaki* | Coursework Preparation |

**Advanced Operations Management - Session syllabus and learning outcomes**

| Lecture | Learning outcomes |
|---|---|
| Industrial Logistics and Transportation | Understand the challenges in designing and managing a logistics system<br>Learn how to determine optimal routing of products in a logistics network |
| Warehouse management | Understand the challenges in operating industrial warehouses<br>Learn how to determine optimal warehouse location |
| Temporary logistics operations | Understand the challenges in and the process of rapid setting up of temporary logistics operations |
| Quantitative approaches for supply chain management | Optimising supplier selection<br>Supply chain configuration<br>Learn quantitative approaches in the effective modeling and analysis of supply chain problems<br>Practice the use of quantitative approaches in a range of supply chain problems such as configuration, work, and profit allocation<br>Discuss how quantitative approaches may complement and are influenced by practical and business issues relating to supply chain management. |
| Quantitative approaches for supply chain management | Optimising supplier selection<br>Supply chain configuration<br>Learn quantitative approaches in the effective modeling and analysis of supply chain problems<br>Practice the use of quantitative approaches in a range of supply chain problems such as configuration, work, and profit allocation<br>Discuss how quantitative approaches may complement and are influenced by practical and business issues relating to supply chain management. |
| Supply chain risk and resilience | Learn how to identify key risks in industrial supply chains<br>Understand the interdependencies between different types of supply chain risks<br>Learn different approaches for quantifying and analysing risk in supply chains<br>Understand industrial approaches to managing supply chain risks |
| Supply chain game | Understand the dynamics that emerge along a supply chain |

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| | Discuss strategies to overcome adverse emergent effects |
| Introduction to Services and Service Design | Understand the economic, strategic and environmental rationales of why manufacturing companies are servitizing<br>Understand the concept of servitization and the key differences between manufacturing and services<br>Understand the five phases of service design thinking, particularly focus on understanding customer/user needs<br>Understand the service – concept, experience and outcome framework |
| Customer service journey and business model innovation | Understand the journey to service from the customers/ users perspective and correspondent set of operations<br>Understand the service business model innovation concept and examples |
| The future of services with digital | Learn the trends and future of services and the role of digital technology in effective delivery and management of services |

**Additional readings will be provided on Moodle.**

## MET-IIB-7: Production Technologies and Materials

Module Leaders: Prof Bill O'Neill

Other IfM staff: Dr Claire Barlow, Prof Ronan Daly, Prof Sebastian Pattinson, Alan Thorne, Dr Florian Urmetzer

Dates: Monday 20 January – Friday 31 January 2025

Location: IfM

Assessment: Production Technologies and Materials lectures form part of the examinable content for the end of year exam (Paper 1).

Assignment [40% (10% group presentation, 30% group report)], End of module assessment [60%]

Module assessment, Thursday 30 January 2025, 09:00 hr. GMT

Group Presentation, Friday 31 January 2025

Group report, electronic submission via Moodle

Submission Deadline: Monday 3 February 2025; 08:45 hr. GMT

**Module Learning Outcomes**

By the end of the module, the students should (be able to):

- Relate their MET IIA learning to a range of industrial contexts
- Understand/appreciate the range of materials, technologies and processes involved in current best practice manufacturing
- Describe future trends in these areas
- Make appropriate choices of materials and manufacturing processes in a business context
- Relate these choices to product and process design

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| **Links to other parts of MET IIB** | | METIIB-4 (assembly, automation, manufacturing systems), METIIB-7 (sustainable manufacturing), Industrial Projects (considering broad influences on manufacturing on products and systems) |
| **Links to MET IIA** | | 3P1, 3P10 (Polymers, composites), 3P2 (production technology control), 3P3 (design for manufacture/assembly), 3P10 (sustainability, biopolymers, medical technology manufacture) |

**PTM – Week 1** *This is a draft timetable and may be subject to changes*

| Time | Monday 20 January | Tuesday 21 January | Wednesday 22 January | Thursday 23 January | Friday 24 January |
|---|---|---|---|---|---|
| 0900 – 1030 | *Introduction to 4 week project*<br>*Frank Tietze*<br>*Introduction to module and to assignment*<br>*Bill O'Neill* | Production Technologies<br>-Assembly 1<br>Assembly & automation<br>*Alan Thorne* | Production Technologies<br>-Additive 1<br>Introduction & AM with polymers<br>*Sebastian Pattinson* | Production Technologies<br>-Ultraprecision 1<br>Introduction & overview<br>*Bill O' Neill* | Materials<br>-Polymers 1<br>Injection moulding<br>*Florian Urmetzer* |
| | | | | | |
| 10:45 – 12:15 | Production Technologies<br>-Chemical processes 1<br>Chemical process industry<br>*Ronan Daly* | Production Technologies<br>-Assembly 1<br>Assembly & automation<br>*Alan Thorne* | Production Technologies<br>-Additive 2<br>Metal AM and High Powered Lasers<br>*Bill O'Neill* | Production Technologies<br>-Ultraprecision 2 Laser technologies<br>*Bill O'Neill* | Materials<br>-Polymers 2<br>Polymer characterisation & advanced applications<br>*Katherine Sanders* |
| | Lunch | | | | |
| 1330 – 1500 | Production Technologies<br>-Chemical processes 2<br>Continuous processes<br>*Andrew Rutter* | Production Technologies<br>-Assembly 2<br>Superconducting magnets<br>*Melanie McGregor* | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | Materials<br>-Polymers 3<br>Biopolymers<br>*Claire Barlow* |
| | Break | | | | |
| 1515 – 1645 | Production Technologies<br>-Chemical processes 3<br>Adhesives<br>*Stuart Thompson* | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** |

**PTM – Week 2** *This is a draft timetable and may be subject to changes*

| Time | Monday 27 January | Tuesday 28 January | Wednesday 29 January | Thursday 30 January | Friday 31 January |
|---|---|---|---|---|---|
| 0900- 1030 | Materials<br>-Advanced Materials 1 Semiconductors<br>*Peter Gleeson* | Materials<br>-Carbon Fibre 1<br>Carbon fibre and composite manufacturing<br>*Benjamin Wood* | **PTM Assignment:**<br>**Group work** | **<u>Module Assessment</u>**<br>**(09:00 – 10:00)** | **PTM Assignment:**<br>**Group presentation** |
| | Coffee | | | | |
| 1045-1215 | Materials<br>-Advanced Materials 2<br>Carbon nanotubes<br>*Michael de Volder* | Materials<br>-Carbon Fibre 2<br>Carbon fibre composite applications in F1<br>*Steve Foster* | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group presentation** |
| | Lunch | | | | |
| 1330- 1500 | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group presentation** |
| | Tea | | | | |
| 1515-1645 | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group work** | **PTM Assignment:**<br>**Group presentation** |

**Production Technologies and Materials – Syllabus and session learning outcomes**

| Syllabus | Session learning outcomes |
|---|---|
| **Production Technologies**<br>**Chemical Processes 1: Chemical Process Industry & Technologies**<br>Definition and categorization of chemical process industry<br>Characteristics of Primary and Secondary manufacturing<br>Characteristics of Continuous and Batch processes<br>The steps in chemical process design<br>How to carry out a hazard and operability study<br>Example unit operations and reactors | Appreciate the range of industries linked to chemical processes<br>Understand the choice between continuous and batch manufacturing based on current practice<br>Develop basic design skills for chemical processes |
| **Production Technologies**<br>**Chemical Processes 2: Adhesives and bonding**<br>Chemistry of adhesives and the batch manufacturing routes for their production<br>Background to the application of advanced adhesives<br>Principal applications of industrial adhesives<br>Approaches taken to testing adhesive properties<br>Considerations when choosing between adhesives for different applications.<br>New developments of adhesive technology | Understand the basic operational and manufacturing principles of adhesives<br>Understand the current range of adhesive formulations and areas of application<br>Understand the importance of adhesives to the wider manufacturing industry |
| **Production Technologies**<br>**Assembly 1: Assembly & Automation**<br>The relationship between product characteristics and assembly method: volume/complexity<br>Overview of different assembly system configurations<br>The advantage/disadvantages of hard/soft automated systems<br>Case studies | Make informed choices of assembly system (including automation) components<br>Appreciate the range of additional supporting processes and activities that are needed to implement such a system<br>Justify a choice of assembly automation system taking into account product lifecycle and flexibility requirements |

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| **Production Technologies**<br>**Assembly 2: Superconducting magnets**<br>Design, materials selection and manufacturing processes for high-field superconducting magnets for medical imaging applications<br>Supply chain and quality issues<br>Assembly challenges | Describe the particular logistic, scheduling and technical problems of manufacture and transport of these very large, high precision devices |
| **Production Technologies**<br>**Additive 1: Introduction & AM with polymers**<br>Fundamental rapid prototyping concepts for the production of 3D objects, with a focus on polymers and metals<br>Application in design and production<br>Additive manufacturing concepts and the drive for higher throughput and mass customization<br>Application studies | Understand the basics of additive manufacturing operations<br>Understand the means by which these technologies can be applied in manufacturing applications<br>Appreciate the benefits and limitations of additive technologies as compared with standard manufacturing approaches |
| **Production Technologies**<br>**Additive 2: Metal AM and High Powered Lasers. Additive manufacturing systems**<br>Key techniques for metal additive manufacturing at industrial scale, materials challenges in metal AM<br>Process challenges in metal AM, Industry applications and case studies<br>Future challenges facing broader adoption of AM | Able to describe steps in each production technology noted by Renishaw<br>Understanding the challenges and limitations in metal AM |
| **Production Technologies**<br>**Ultraprecision 1: Introduction & overview**<br>Ultra-precision production technologies<br>Definition of ultra-precision manufacturing<br>Manufacturing processes at the very small scale, their characteristics and limitations<br>Build an understanding of a range of micro and nano manufacturing ultra-precision techniques including a range of lithographic, roll-to-roll printing and ion-beam approaches | Understand the range of micro manufacturing and ultra-precision techniques for processing components from metals, ceramic and polymers<br>Understand their potential and limitations in manufacturing next generation products<br>Be aware of the choice of manufacturing techniques for different applications |

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| **Production Technologies**<br>**Ultraprecision 2: Laser technologies**<br>Advanced processes – laser technologies<br>Global context of industrial laser manufacturing markets<br>Modern high power industrial lasers and their systems<br>Laser manufacturing across the length scales<br>Principal applications of industrial laser systems<br>Future developments of laser technology | Understand the scale, operation and impact of high power industrial laser systems in the global market place<br>Understand the means by which lasers can manipulate materials for manufacturing applications<br>Understand the basic laser based manufacturing techniques and technologies<br>Appreciate where and how industrial lasers may replace traditional manufacturing technologies |
| **Materials**<br>**Polymers 1: Injection moulding**<br>Injection moulding basics<br>Machine setup (how do they work?)<br>Forms, flow analysis<br>Potential quality issues<br>Other processes: Bottle blowing and filling | Understand concept of injection moulding<br>Comprehend the process of injection moulding<br>Appreciate problems with the process<br>Know basic quality aspects |
| **Materials**<br>**Polymers 2: Polymer characterization and advanced applications**<br>Definitions, properties and applications of advanced polymers<br>Characterisation techniques to interrogate polymer properties | Understand the changing role of polymers in industry<br>Understand the basics of sampling, measuring and validating polymer materials |
| **Materials**<br>**Polymers 3: New opportunities in biopolymers**<br>Definitions, properties and applications of biopolymers<br>Environmental issues – examples of life-cycle assessments | Understand the production, applications and properties of various common biopolymers and the environmental consequences of their use |
| **Materials**<br>**Advanced Materials 1: Semiconductor manufacturing** | Understand the key steps in fabricating current transistor technologies |

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| Description of production steps from the growth of silicon crystals to the delivery of packaged arrays of transistors.<br>Description of the key materials, processes and structures that are in a current transistor.<br>An introduction to Moore's Law<br>Explanation of how Intel (as the industry example) have made changes to continue Moore's Law<br>An introduction to the major barriers facing the industry and the changes that may enable continuation in the decrease in transistor size. | Understand key steps in the evolution of transistor technologies<br>Understand how production processes can influence the achievable feature sizes in this field<br>Understand how materials development can influence the achievable feature sizes in this field |
| **Materials**<br>**Advanced Materials 2: Carbon Nanotubes (CNT) and their applications**<br>Structure, properties, synthesis and processing of CNTs<br>Applications and market development<br>Safety | Understand the manufacturing processes, properties and a range of potential applications of CNTs |
| **Materials**<br>**Advanced Materials 3: High performance materials & biomimetics**<br>Discussion of definition of 'high performance'.<br>Examples of materials with these attributes for particular applications<br>Discussion of looking to nature for inspiration when creating high performance materials<br>Examples of biomimetic materials and the reasons for their high-performance characteristics | Appreciate the range of material properties that may need to be optimized for engineering applications.<br>Understand the principles behind some examples of material property optimisation. |
| **Materials**<br>**Carbon Fibre 1: Carbon fibre and composite manufacturing**<br>Manufacturing process steps when fabricating core, carbon fibre and prepreg<br>Applications for carbon fibre and associated materials and processes to fabricate composite structures<br>Development of the composites business and future prospects for CFRP | Appreciate the technological, logistic and economic complexities of CFRP manufacture and use in composite structures<br>Understand the constraints and opportunities for wider application of CFRP |

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| **<u>Materials</u>**<br>**Carbon Fibre 2: Carbon Fibre Composites – F1 applications**<br>Materials selection and design for high performance racing cars<br>Quality assurance and testing<br>Process steps when fabricating components from carbon fibre composites | Describe and justify the range of applications of carbon fibre composites and other advanced materials in Formula 1 racing car design<br>Understand the materials processing methods used and the reasons for their selection |

**Production Technologies and Materials - Module Assignment**

**Objective**

The purpose of the assignment is to give students the opportunity to experience first-hand the factors affecting the choice of materials and production/assembly method for a variety of products, drawn from a range of industry sectors.

**Module Context**

During the module, students hear presentations covering alternative approaches to manufacturing components and assembling products, ranging from simple manual assembly methods to fully automated systems based on a variety of architectures. Design for assembly and factors affecting choice of materials and processes are also addressed, along with details about specific materials and production processes across a range of manufacturing industries. The assignment allows the students to apply these ideas to real examples of materials and process choices along with assembly operations.

**Assignment Activities and Process**

Students are grouped into teams of four or five. Each team is allocated a product.
The challenge is for the team to undertake an analysis of the product design, materials choice, the manufacturing system capable of producing it and the business context in which it is manufactured. The results of each project group are presented in a debrief to the class at the end of the module and a submitted report. Details of the brief and the assessment criteria are presented on Day 1 of the module.

**Debrief**

Each team prepares a 20-minute presentation for the entire class at the end of the module, summarising their analysis and findings. The presentation is assessed based on standard criteria, i.e. were the results presented in a clear and competent way? Was good use made of visual aids? Were the presenters audible, enthusiastic and articulate? Were the technical aspects of the project adequately handled? Were questions well handled?

**Report**

Each group presents a short report that summarises their findings during the course of the assignment. Electronic copies of the reports are to be summited via Moodle Submissions by 08.45hr on Monday 3 February 2025

## MET-IIB-8. Sustainable Manufacturing

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| Module leaders: | Dr. Nathanial Cooper |
| Other IfM staff: | Prof Steve Evans, Dr Claire Barlow, Ian Bamford, Dr Veronica Martinez |
| Dates: | Monday 17 February – Friday 21 February 2025 |
| Location: | IfM |
| Assessment: | Sustainable Manufacturing lectures form part of the examinable content for the end of year exam (Paper 1 and Paper 2).<br>Written case study assessment<br>Electronic submission via Moodle online submissions<br>Submission Deadline: Monday 24 February 08.45hr GMT |

**Module Learning Outcomes**

By the end of the module students should be able to demonstrate knowledge and understanding of:

- What is meant by sustainability in an industrial context
- The drivers of and barriers to sustainable manufacturing
- Systems approaches to sustainability
- How businesses may respond to the sustainability challenge
- Critical materials and sustainability

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| **Links to other parts of MET IIB** | Strategy and Marketing | The economical, ecological and social principles of sustainability have implications in the corporate and operations strategy and marketing |
| | Production Technology and Materials | Links to product design, sustainable materials and sustainable manufacturing processes. Links to disassembly and the repurposing strategy of the circular economy |
| **Links to MET IIA** | 3P5 | 3P5 introduces the concepts of maintenance and scheduling maintenance, both important to the recycling, repurposing and circular business models of this module |
| | 3P10 | The 4 lectures on Sustainability provide foundation knowledge for industrial ecology and other relevant matters relating to sustainable manufacturing |
| | Industry Visits | The elements product design for sustainable products brands of this Strategy and Marketing Module are complemented by the MET IIA industry visits<br>The 'sustainability' theme in the visits program provided real-life examples of approaches to sustainable manufacturing in different sectors |

**Sustainable Manufacturing** *This is a draft timetable and may be subject to changes*

| Time | Monday 17 February | Tuesday 18 February | Wednesday 19 February | Thursday 20 February | Friday 21 February |
|---|---|---|---|---|---|
| 0900-1030 | Module Introduction<br><br>Industrial Sustainability<br>*Nathanial Cooper* | Packaging and Sustainability<br><br>*Nathanial Cooper* | Energy Use & Storage<br><br>*Nathanial Cooper* | Imperfect World: Sustainability in Real Factories<br>*Daniel Summerbell*<br>*Carbon Re* | Sustainable Business Models and the Circular Economy<br>*Veronica Martinez* |
| | | | | | |
| 1100-1230 | Value Explorer Tool<br><br>*Ian Bamford* | Critical Materials and Sustainability<br>*Nathanial Cooper* | EcoAudit Reprise: Carbon Footprint Assessment<br><br>*Hugh Shercliff* | Imperfect World: Sustainability in Real Factories *(continued)*<br>*Daniel Summerbell* | Blockchain and the Circular Economy<br>*Veronica Martinez* |
| Lunch | | | | | |
| 1330-1500 | Energy and Life Cycle Assessment<br>*Stuart Scott* | Case study: AB Sugar Wissington<br>*Gary Punter*<br>*AB Sugar Wissington* | Free | 13.30-15.30 Imperfect World: Sustainability in Real Factories *(cont.)*<br>*Daniel Summerbell* | Case Study: Progressive Energy<br><br>*Chris Manson-Whittan*<br>*Progressive Energy* |
| Tea | | | | | |
| 1530-1700 | *Module Assessment Introduction*<br><br>*Nathanial Cooper* | *Module Assessment Preparation* | Free | *Module Assessment Preparation* | *Module Assessment Submission Date:*<br>*24 February 2025 08:45 AM GMT* |

*Themes*: **Urgency and need**; Introduction to tools & assessment method; Application of tools & assessment method; Real world case studies

**Sustainable manufacturing – Session syllabus and learning outcomes**

| Syllabus | Learning outcomes<br>Demonstrate understanding of**:** |
|---|---|
| Industrial Sustainability | Implications on resource usage and GHG emissions of manufacturing industry as a whole |
| Critical Materials and Sustainability | Environmental impact of materials production, basis for predictions of scarcity, mitigation measures. |
| Energy and Life Cycle assessment | The technical and economic viability of different energy sources for global energy supply. |
| Packaging and sustainability | Using systems approaches to assess the contribution of packaging to carbon footprints in the food industry |
| Case study: Progressive Energy | Implementation of renewable energy projects in the context of national policy and government regulations. |
| Case study: British Sugar, Wissington | Implementation of systems approach to resource efficiency within a large process industry site |
| Energy Use & Storage | Energy demand, availability, and storage, and the implications for national and local sustainability |
| Imperfect World: Sustainability in Real Factories | Approaches and methods to quantify approximate potential improvement, including Zero Loss Yield and Sustainability by Design concepts |
| Value Explorer Tool | An overview of how businesses can innovate their business models towards sustainability introducing industry proven tools to better understand sustainable value and business transformation |
| Improving Sustainability | Approaches and methods that can lead to sustainability improvement in factories |
| EcoAudit Reprise: Carbon Footprint Assessment | How to assess the carbon impact of products at each stage of their life using digital tools (Grant Edupack / EcoAudit) |
| Sustainable Business Models | Certain business models can encourage the circular economy and prioritize sustainability |
| Blockchain and the Circular Economy | Implementing blockchain tracking can help to ensure responsible supply chains and encourage the circular economy |

**Reading List**

Books

| | |
|---|---|
| ASHBY, M.F. | *Materials and the environment*, Butterworth-Heinemann 2012, ISBN 978-0-12-385971-6 |
| LACY, P., RUTQVIST, J. | *Waste to Wealth: The Circular Economy Advantage.* Palgrave Macmillan, 2015 |
| VON WEISZACKER E, LOVINS A.B., LOVINS L.H. | *Factor Four: doubling wealth, halving resource use.* Earthscan publications, 1997 |

Book Sections

| | |
|---|---|
| MACKAY, DJC | *Sustainable energy – without the hot air (10 page synopsis),* http://www.withouthotair.com/synopsis10.pdf, 2008 |

Articles

| | |
|---|---|
| MARTINEZ V., ZHAO M., BLUJDEA C., HAN X., NEELY A. AND ALBORES P. | *Blockchain-driven customer order management.* International Journal of Operations & Production Management, 39 (6/7/8): 993 1022. https://doi.org/10.1108/IJOPM-01-2019-0100 |
| SABERI S., KOUHIZEDEH M., SARKIS J. AND SHEN L. | *Blockchain technology and its relationships to sustainable supply chain management.* International Journal of Production Research (2019). https://doi.org/10.1080/00207543.2018.1533261 |
| TKACZYK A. H., et al. | *Sustainability evaluation of essential critical raw materials: cobalt, niobium, tungsten and rare earth elements.* J.Phys. D: Appl. Phys. 51: 203001. (2018) https://iopscience.iop.org/article/10.1088/1361-6463/aaba99/pdf |
| YANG, M., EVANS, S., VLADIMIROVA, D. and RANA, P. | *Value uncaptured perspective for sustainable business model innovation.* Journal of Cleaner Production, 2017. 40 (3), 1794-1804. https://doi.org/10.1016/j.jclepro.2016.07.102 |

## MET-IIB-9: Leadership and Managing People

Module leader: Prof Tim Minshall

External speakers: TBC.

Dates: Monday 24 February – Friday 28 February 2025

Location: IfM

Assessment: Leadership and Managing People lectures form part of the examinable content for the end of year exam (Paper 2)

Written analysis of case study situation

Submission Deadline: Monday 3 March 2025; 08:45 hr. GMT

**Module Learning Outcomes**

By the end of the module the students will:

1. Be able to demonstrate understanding of selected core theories that underpin the management of people and the role of leadership, and their relative strengths and weaknesses, building on the foundations provided in MET IIA.
2. Understand how your own leadership and management capabilities can be developed throughout your career.
3. Understand how different leadership and management approaches are used in different contexts, ranging from start-ups to multinationals, and commercial to academic/policy organisations.
4. Appreciate the evolving range of people-related issues that can occur as firms grow and when implementing change, and have a basic understanding of key approaches to change management in different contexts.
5. Be aware of the people-related challenges of dealing with significant technological change from national level policy and firm level management perspectives.
6. Understand the role of people in successful business collaborations and, in particular, issues of trust and contracts.
7. Be aware of the messy practical details of leadership and people management.

| | | |
|---|---|---|
| **Links to other parts of MET IIB** | EGP | How companies and governments respond to disruptions |
| | TIM | Technology acquisition; open innovation |
| | S&M | Leadership; strategic decision making |
| **Links to MET IIA** | 3P6 | Culture, motivation, leadership, change management |
| | 3P7 | Opportunity cycle of enterprise; Recruiting, motivating, measuring, developing, retaining |

| Time | Monday 24 Feb | Tuesday 25 Feb | Wednesday 26 Feb | Thursday 27 Feb | Friday 28 Feb |
|---|---|---|---|---|---|
| **0900-1030** | Module introduction.<br>*Tim Minshall*<br><br>**Panel discussion:**<br>Leadership and managing people experiences from ex-METs: *TBC.* | Leadership and management issues in start-up companies.<br><br>*Industry speaker (TBC)* | How to continuously develop your leadership capabilities and lead change.<br><br>*Industry speaker (TBC)* | Management of people in partnerships and collaborations<br><br>Management of change at the national level for new technologies<br>*Tim Minshall* | Module Assessment preparation. |
| Coffee | | | | | |
| **1100-1230** | Review of core theories on leadership, managing people, and change management.<br><br>Assessment briefing<br>*Tim Minshall* | Leadership and management issues in multinational corporations.<br><br>*Industry speaker (TBC)* | Leadership and management in during extreme growth and high uncertainty.<br><br>*Industry speaker (TBC)* | Module summary<br><br>Student-requested topics<br><br>*Tim Minshall* | Module Assessment preparation. |
| Lunch | | | | | |
| **1330-1700** | **13:30 - 14:00** Daily Q&A Session<br>**14:00 - 17:00** Module readings and assessment preparation | **13:30 - 14:00** Daily Q&A Session<br>**14:00 - 17:00** Module readings and assessment preparation | **13:30 - 14:00** Daily Q&A Session<br>**14:00 - 17:00** Module readings and assessment preparation | **13:30 - 14:00** Daily Q&A Session<br>**14:00 - 17:00** Module readings and assessment preparation | **<u>Module assessment Submission Date:</u>**<br>**Monday 3 March**<br>**Time: 08:45 GMT** |

**Leadership and Managing People – Session syllabus and learning outcomes**

| Syllabus | Learning Outcomes |
|---|---|
| **Introduction**<br>Assessment briefings | To understand what will be covered in this module.<br>To understand how this module will be assessed. |
| **Panel Discussion:**<br>Why this stuff <u>really</u> matters in different contexts. | To appreciate the 'real world' importance of this material, how different people approach these issues in different ways, and how others have developed their leadership and management capabilities. |
| **Review of core theories** | To be reminded of the core theories from MET IIA that underpin real world leadership, people management, and change management. |
| **Leadership and management issues in start-up companies**<br>**Leadership and management issues in multinational corporations**<br>**Leadership and management in conditions of extreme uncertainty and during extreme growth** | To understand the role and tools of management and leadership in smaller, early-stage organisations large complex organisations, in firms experiencing 'hyper-growth', and in organisations facing extreme uncertainties. |
| **How to continuously develop your leadership capabilities and develop your teams.** | To be aware of different ways you can: develop your leadership and management capabilities over your career(s); develop and make best use of networks (mentors, mentees and supporters); maintain learning; and seek out new challenges. |
| **Management of people in partnerships and collaborations** | To be aware of the specific people management issues in successful business collaborations and, in particular, issues of trust, contracts and relationship management. |
| **Leadership of change at scale for new technologies** | To be aware of the leadership and people / skills-related challenges when attempting to support the diffusion of a new technology at scale. |
| **Reflection on your own experiences** | To be able to draw useful lessons from the project experiences during MET. |

**Reading List:**
Module readings provided on Moodle.

## Industrial Projects

## Introduction

Industrial projects are a distinctive feature of METIIB and are a key element both for teaching and assessment. The aims of the industrial projects are to:

1. provide an experiential learning opportunity to support and extend the theoretical aspects of the taught modules;
2. develop a firmer understanding of the problems and difficulties associated with the application of taught material and concepts in an industrial setting;
3. allow you to practice the skills of managing yourself and others: project planning; time management; seeking, identifying and classifying critical information from mass data; co-operation and influencing others;
4. enable you to appreciate the importance of good communication, both formal and informal, and to practice the skills of evidence-based report writing and business presentations.

METIIB industrial projects consist of three team-based projects (two in Michaelmas and one in Lent term) as well as one individual project in Easter term.

## Setting up projects

The Michaelmas and Lent term projects are run in companies, each selected by a University Supervisor. The company and the University Supervisors agree project briefs for the student team, appoint Company Supervisors with overall responsibility for the projects, and a contact person for each team.

The Long Projects in Easter term are run by individual students. Based on the experience gained from the Michaelmas and Lent projects, students should develop and scope their own projects, which is an excellent opportunity to design a project that fits the individual student's preferences. MET teaching staff support students developing their projects (see further Long Project section below).

## Project deliverables

MET projects are not artificial exercises: they are aimed at solving real, current problems in companies and the results are important to them.

The University's policy of academic misconduct and plagiarism apply to any deliverable produced by students during the projects. Details are available on the University's website: www.plagiarism.admin.cam.ac.uk

For each project, the company and university supervisors expect two deliverables:

### *1. End of project presentations*

This is particularly important to the company and is normally made to senior members of the operations and management team. The presentation typically takes place in the afternoon or late morning of the final project. The University Supervisor also attends, as the presentation

is an integral part of the project marking. Presentations normally last for a maximum of 30 minutes (not more than 45min, if delivered in a more interactive way) followed by 15-30 minutes of questions. Question normally come from the company staff rather than the University Supervisor. The total time for the presentation should be agreed with the University Supervisor well in advance.

The presentation is for the benefit of the company rather than for the supervisor. However, students should also see the presentation as an opportunity to collect further feedback on their recommendations. That feedback can still be taken onboard for the final report.

All students are expected to contribute in some way to the presentation, but getting everyone to speak might not be an effective use of time. High standards of organisation, structure, use of evidence, delivery and visual aids are expected.

***2. Project reports***

Following the presentations, every team needs to submit a joint project report. The report is intended to ensure that the need for the project, the work done (incl. use of evidence and systematic approach/ analysis), the results and recommendations are fully documented. The report should be a stand-alone document containing sufficient information to give a newcomer to the project all relevant information they need to pick up the project and continue it. Please keep in mind that the reports might be distributed across the company to people, who were not involved in the project.

Requirements for METIIB report style are given in Appendix 3 of this handbook. Particular attention should be paid to a coherent chain of arguments leading to your recommendations and conclusions, the use of appropriate and properly documented evidence and analysis as well as the style, clarity and format. Reports usually start with an Executive Summary of max. 1 page giving an overview of the tasks for the whole project, the applied methods/ techniques and the key outcomes/ recommendations. If sub-teams are formed, the report should reveal which team has worked on which sub-project. Each team needs to be aware of what the other teams have done, and ensure that the conclusions and recommendations are consistent. This will be checked by the University Supervisor.

Generally speaking, reports should be as long as appropriate for the complexity of a project. They got to display sufficient detail for an informed reader, who knows the company, to understand what the project is about, what students have done and how this has led to the results and subsequent recommendations. The report should be kept to the minimum length focusing only on the content relevant to the specific project Additional, potentially interesting content (e.g. additional observations about problem areas made during the project) can be submitted separately to the company or could be included in appendices to the report. There is no strict word/page limit, but students should discuss the length of the report with the University Supervisor.

For certain projects, in the past, it has proven helpful that students produce an additional handover document that provides additional information that the company needs to fully understand what the project team has done. This might include fuller explanations, contact addresses, supplier brochures, computer printouts, source code explanations etc.

During the week following the project the University Supervisor holds a supervision with each team and gives detailed feedback on the performance. Modifications to the report may be necessary following the supervision. A final version of the report must be submitted following

the supervision, and will be checked by the supervisor before being sent off to the company. During the supervision, students have an opportunity to share their perceptions of the project and support they received.

**Please read the following carefully.**

- Reports must be in the MET standard report format – see example given in the Appendix 3 of this handbook. Reports in any other format are not acceptable. A template for this style is available on Moodle.

## Projects timetable

The projects are structured to expose students to problems of increasing complexity, and with increasingly unspecific objectives and methodological guidance. The time allocated to each project also increases as MET IIB progresses. The intention is that this sequence of projects will provide a structured transition from the academic to the industrial setting. The project sequence is as follows:

| | | |
|---|---|---|
| **Michaelmas Term**<br>(3 day – Induction project and 2-week project) | Groups of 7-8 students (induction projects) and of 2 (2-week project) | Investigating company problems principally of a technical nature typically related to manufacturing process mapping and optimization |
| **Lent Term**<br>(4 (2+2) week project) | Groups of 3-5 students | Addressing a range of substantive company issues, spanning all aspects of manufacturing operations |
| **Easter Term**<br>Long project<br>(7 (1+6) weeks) | Individual | Large variety of projects within the IfM's broad definition of manufacturing |

Before embarking on the first induction project all students have to sign the risk assessment that covers travel related risks. For long projects, particularly for those taking place abroad, students might need to complete separate risk assessments.

## Project execution

Working with company staff to complete projects to tight deadlines requires considerable tact and presence – and this is one of the key learnings from the course. The following guidelines should be observed:

i. students are subject to the same local rules and conditions as any other employee;
ii. students should work at least the normal working hours;
iii. a detailed programme of work should be drawn up at least by the second day;

iv. regular review meetings for the team should be timetabled, even if they are in regular contact with each other;
v. all information that is used in the project must be substantiated by evidence – hearsay is not acceptable;
vi. interviews with members of the company are best limited to 30 minutes. It is better to arrange a series of short interviews than to make a major interruption to the interviewee's schedule;
vii. factual information should be recorded as the project proceeds, in a form suitable for inclusion in the final report (make use of appendices). Attention should be paid to data privacy and confidentiality.

## Responsibilities

For the Michaelmas and Lent term projects, each team should appoint a **Team Leader** to be responsible for co-ordinating all arrangements, particularly the communication with the university and company supervisors.

A **University Supervisor** makes pre-project arrangements with the company; briefs students before the project; is generally available for contact during the project and attends the final presentation and provides feedback and guidance during supervisions (incl. feedback on the draft report so that students can produce the final version).

A **Company Supervisor** is an employee from the company who has overall responsibility for the project and is the main day-to-day contact for the students during the project.

MET covers costs (e.g. travel, accommodation) associated with all but the individual long projects in Easter term. The company hosting a student is expected to cover the costs for that project, including costs for the supervisor to travel for attending the final presentation.

## Assessment

Assessment of the project work is based on two deliverables: (1) the presentation and (2) report. The five marking criteria include the effectiveness of meeting objectives, systematic evidence-based investigation and quality of presentations and report, with appropriate consideration given to the project context, such as difficulty of task and level of support provided by the company. Appendix 2 of this handbook contains examples of the marking form to be used by the University Supervisors that shows the weighting given to each marking criteria.

All projects are marked independently by the University Supervisor and another MET staff member, who then will agree on the marks. In other words, all project reports are marked twice – by the University Supervisor and by an Assessor. Please keep in mind that the Assessor's only contact with the project is through the report, so their most important contribution is commenting on how well the report functions as a standalone 'handover document'. The induction project will only be marked by the University Supervisor.

Students receive written feedback from their supervisor via CamCORS.

**General project report submission procedure**

i. At the time of the final presentation students should agree with the University Supervisor a date for a supervision to take place in the second part of the next week after they have submitted their draft report to the teaching office. The purpose of that supervision is for the supervisor to provide a general review of the project experience and more specifically to provide feedback on the project draft report and team performance.

ii. Before leaving the company, the students should leave a full set of the presentation slides with their company host and not take with them any sensitive data that belongs to the company. A copy of the presentation slides should be sent to the University Supervisor.

iii. The project report must be submitted via Moodle by the due date. If a hand-over file is produced this must be submitted at the same time so that the markers have a full appreciation of what has been achieved.

iv. The IfM Teaching Office staff will forward the files to the University supervisors and second markers for comment and marking.

v. The project supervision, and any amendments to the report must be completed before the final submission deadline. The original draft report, including supervisor's comments, and the amended final report must be handed in by this deadline.

vi. The IfM Teaching Office staff send the amended reports and possibly handover files to the companies for comment. If their comments require further modification to the report it will be returned to the students. **Modifications must be made and the reports returned for final distribution within seven days. Details of all hand in dates are given in the section entitled "Industrial Project Report Hand-In Dates 2024-2025".**

**Late submission**

A key feature of industrial project work is adherence to timescales and deadlines. To reinforce this there will normally be automatic penalties for late submission of reports as follows:

| Submission | Penalty |
|---|---|
| Penalty for lateness: | 20% of marks per week, or part week, that the work is late (see MET Penalty Policy in Appendix 1) |

The only exception will be when an extension request is submitted to the IfM Teaching Office staff BEFORE the due date, or in extreme circumstances with the written agreement of the MET IIB Course Director.

## Attendance

Due to the nature of projects attendance is compulsory.

## Project supervisions

For all group projects in Michaelmas and Lent term a University Supervisor is appointed who is responsible for:

i. agreeing the project with the company;
ii. preparing a project brief which includes a statement of the project objectives and deliverables, some background and guidance on how to proceed;
iii. discussing progress with students during the project;
iv. attending the final presentation to the company, and providing feedback to students;
v. marking the project report;
vi. providing feedback on the report so that it can be modified before being sent to the company.

Students are in charge of setting up their Easter term individual project themselves and find a supervisor from the MET teaching staff.

Every project will need to have a Company Supervisor to look after the day-to-day running of the project in the company.

## Project Feedback

Feedback on the project experience is important so that both individual student performance and the project processes can be improved. The University Supervisors will provide feedback to the students based upon input provided by the Company Supervisor, observations of the presentations made during the project, and the reports.

## Confidentiality

Companies may require students to sign a confidentiality/ non-disclosure agreement (NDA's), usually prior to the start of the project. In such case, the University Supervisor will guide the students through that process supported by the university's contract team. Students must NOT sign any such agreement given to them by the company without consulting the University Supervisor. Students are strongly advised to strictly adhere with the regulations set out in the agreement.

During projects, students must be mindful when using cloud-based tools. Information from the company should not be uploaded into cloud services, particularly AI tools (e.g. ChatGPT), certainly not any confidential company data.

## Complaints

In case of problems arising along the projects, such as the support students receive from the company or a team member, the University Supervisor is the students' first point of contact. Students are advised to raise problems with their supervisor as early as necessary, possibly after having made a reasonable effort to solve the respective problem internally first. Students should avoid informing their supervisor too late as then the options for the supervisor to interfere are likely to be more limited.

## Michaelmas term: The Induction and Two-Week Projects

During the Michaelmas term student will complete two projects. The first project is known as the induction project and will lasts three days. This project serves as an introduction to the industrial project's component of MET IIB. The second project lasts for two weeks and forms the core of the Michaelmas projects.

### Project objective and aims

The overall objective of the Michaelmas projects is for students to investigate and help solving primarily technical/ industrial problems, which are often process mapping and optimisation problems.

During the induction project the focus typically is on investigating and systematically mapping a process in order to identify (diagnose) problems, typically related to a certain (part of a) manufacturing process. The two-week project is typically dedicated more to developing and recommending solutions to problems associated with certain manufacturing related processes.

The aims of the Michaelmas projects are to:

i. gain first hand insights to the key functions in a typical manufacturing company;

ii. enable you to make relevant recommendations to the management team based on evidence gathering, analysis, interpretation and collation of data;

iii. enable you to further develop your interpersonal and project management skills necessary to work as part of a team towards a specific time constrained objective.

iv. during the induction project, to provide a first non-assessed experience of MET IIB style project work.

### Agreeing projects

For the 2-week projects a list is made available in advance and supervisors introduce the projects in class approximately two weeks before the project start date. Students are encouraged to state preferences and every effort is made to accommodate them. For the induction project students will be assigned to companies prior to the start of term.

### Project reporting and assessment

Both at the end of the induction project as well as the two-week projects, students will have to deliver oral presentations to the company and written reports. In other words, for this Michaelmas projects, students will have to deliver two presentations and two reports, of which the first set serves a 'training' purpose.

For the Michaelmas projects, both parts are assessed. The induction project is assessed for teams using the marking form shown in the appendix in the same way as the other projects forthcoming later in the METIIB programme, but the marks do not count towards the final degree: the feedback is intended to ensure students are calibrated for subsequent projects. The 2-week project is assessed in a similar way. However, the marks for the second project count towards the final degree.

**Project and assessment timetable**

| | **Timetable for 3-day project** | **Timetable for 2-week project** |
|---|---|---|
| Duration: | 9 October to 11 October | 28 October to 8 November |
| Company presentation: | Afternoon (possibly late morning) 11 October | Afternoon (possibly late morning) 8 November |
| Draft Copies - Moodle electronic submission | By 8:45 hr. BST Monday 14 October | By 8:45 hr. GMT Monday 11 November |
| Supervision with University Supervisor: | By end of Friday 18 October | By end of Friday 15 November |
| Final Copies - Moodle electronic submission | By 8:45 hr. BST Wednesday 23 October | By 8:45 hr. GMT Wednesday 20 November |
| Reports sent to companies: | By Friday 25 October | By Friday 22 November |

**IMPORTANT NOTE: The assessment is made on the first report version, <u>not</u> the revised (final) version.**

**Project implementation**

The students, usually in of 2-3 team, assume joint responsibility for the project. The project might be split up into task-specific sub-projects, e.g. related to different parts of the company or a specific manufacturing process; taken together these sub-projects are likely to cover a substantial part of the main areas of the company.

## Lent term: The Four-Week Projects

The four-week projects are split into two parts of two weeks each and a break of two weeks in between. The break is part of the project and students are encouraged to think about how to best use it to still progress the project. In the past, we have seen examples of students delivering a first version of a prototype at the end of the first part. The company's engineers were then asked to test and trial it during the break and complete a questionnaire. When students returned for the second part they started with analysing the feedback provided via the questionnaire as input to then develop a second version of the prototype. Other students have used the break, for instance, for the company to order material so students could start right away building a workstation prototype when they return for the second part.

### Agreeing projects

For the 4-week projects a list is made available in advance and supervisors introduce the projects in a class meeting approximately two weeks before the project start date. Students are encouraged to state preferences and every effort is made to accommodate them.

### Project objective

The overall objective of the 4-week projects is for students to help solve industrial problems that have some technical, but also some business-related components. Projects are typically designed so that students are asked to conduct an in-depth problem analyses in the first part, then develop solutions and propose recommendations in the second part. Often 4-week projects involve some actual design / development of an artefact (e.g. work station), occasionally even a software tool.

### Project reporting and assessment

Students have to deliver a presentation to the company at the end of the second part, followed by a detailed project report. Both the presentation and the report are part of the assessment using the five marking criteria as explained above. Please see the appendix for the assessment form.

### Project and assessment timetable

| | **Timetable for 4-week project** |
|---|---|
| Duration: | Part 1: 3 February – 14 February<br>Part 2: 3 March – 14 March |
| Company presentation: | Afternoon (possibly late morning) on 14 March |
| Draft Copies - Moodle electronic submission. | Before 8:45 hr. GMT Monday 17 March |
| Supervision with academic supervisor: | By end of Friday 21 March |
| Final Copies - Moodle electronic submission. | By 8:45 hr. GMT Wednesday 26 March |
| Reports sent to companies: | By Friday 28 March |

**IMPORTANT NOTE: The assessment is made on the first "draft" report version, <u>not</u> the revised final version.**

**Project implementation**

The student group allocated to a company assume joint responsibility for the project. They work in teams of 3-5, possibly split up into task-specific sub-projects related to different parts of the company; taken together these sub-projects are likely to cover a substantial part of the main areas of the company.

## Easter term: The Long Project

The Long Project is a substantial individual-student piece of work which all students undertake during a six-week period in Easter term. A preparation and scoping week is timetabled towards the end of Lent term. **In contrast to the other projects, which are organized by University Supervisors, students themselves are responsible for developing, planning and organizing their Long Project.**

### Long Project requirements

The Long Project can take many forms, but there are some essential requirements as follows:

i. projects must include a substantial 'manufacturing' content. In this context manufacturing is taken to mean the very wide definition adopted by the IfM and used as a basis for MET teaching;

ii. projects must be completed by individuals and not by groups as with earlier projects;

iii. the project must be a clearly defined piece of work, usually aimed at solving a specific problem. Projects often arise from previous work done by a company but the starting point and boundaries of the student's work must be clear. It must be possible to demonstrate exactly what the student has contributed;

iv. projects must be agreed in consultation with the University Supervisor and the company contact;

v. projects typically consist of a detailed scoping study undertaken in the preparation week towards the end of the Lent term, a data gathering and analysis phase, some degree of solution generation, results leading to implementation or trialled implementation;

vi. the scoping study must be agreed with the Company and University Supervisor and will include:

- assessment of the subject area to determine key issues requiring investigation;
- preparation of a project brief including background, objective and approach to be taken;
- preparation of a project time line (GANTT chart).

### Agreeing Long Project topics

In contrast to the 2- and 4-week project, the long projects should be developed by students themselves. However, MET staff may make suitable projects available for students to choose from via a Moodle page. Students will be introduced to the project selection process in Michaelmas term.

To develop projects effectively, students should consult with MET teaching staff at the earliest opportunity. Staff can help to generate a viable project, e.g. choosing an appropriate subject area, making sure there is enough academic content to satisfy the course requirements as well as doing something worthwhile for the company.

The IfM website can help identify staff members with research interests, or any staff member can be consulted for advice. IfM has many links to companies in UK and abroad and students are encouraged to use this expertise.

Students have to indicate on their Long Project Preference Questionnaire if they plan to pursue an own (i.e. self-developed) project or pick up a topic provided by a supervisor. All projects need to be agreed with the MET IIB Director and Projects Coordinator towards the end of January. All proposals will be reviewed by an internal committee, which will approve projects or come back to students asking for adjustments.

After projects are approved students should ensure to start planning for the preparation week. Students should contact their company to agree the time they will be spending on the company site during the preparation week as well as the university supervisor early to arrange a meeting early in the preparation week.

**Long Project report and assessment**

Reporting and assessment arrangements are not exactly the same as for shorter projects. The key differences are as follows:

i. *Length of Report*: Long project reports are expected to convey more information, and more detailed information, than reports for the other projects, so they should be more carefully structured and written. The report should therefore be as long as is necessary to include everything which is relevant. However, length does not correlate with quality. It is usually more challenging to keep reports short. A typical report length would be 40-50 pages (excluding references and appendices). The length of the project report should be discussed and agreed with the University Supervisor.

ii. *Report Scope*: The project report must be complete in itself and not refer to or rely on a separate hand-over document. This means that it should convey a complete picture of the project to someone who has not been involved in it. For example, someone in the company should be able to pick up the report and use the material, or another student should be able to follow on the project from where it leaves off.

iii. *Assessment:* As with previous projects, long projects are graded twice - by the University Supervisor and by an Assessor, who will be another experienced MET project supervisor. The Assessor's only contact with the project is through the report, so their most important contribution is commenting on how well the report functions as a 'handover document'.

**IMPORTANT NOTE: The assessment is made on the first "draft" report version, <u>not</u> the revised (final) version.**

**Long Project timetable**

The table on the following page indicates the sequence of events and key actions to set up the Long Project.

**Long Project Timetable**

| | |
|---|---|
| **21 October 2024** | Students are introduced to the Long Project Timetable.<br>Students briefed on scope and requirements for projects.<br>Students begin search for potential project topics.<br>Students start meeting potential long project supervisors. |
| **18 November 2024** | Students return Form 1 to IfM Teaching Office outlining their interests and ambitious for the long project.<br>Preliminary allocation of supervisors by project coordinator. |
| **16 December 2024** | Students to return Form 2 incl. protocol summarizing the meeting with the supervisor. The form needs to be signed by the supervisor. |
| **24 January 2025** | Submission of project proposal Form 3 and cut-off date for student self-selection of projects. Students without a suitable project can subsequently be assigned a project. |
| **17 March 2025** | Start of preparation week. By the end of the week students should have agreed a detailed project brief incl. Gantt chart type of project visualization with University and Company Supervisors. |
| **21 March 2025** | Electronic submission of project brief to Teaching Office and project Supervisor. |
| **5 May 2025** | Projects start. |
| **13 June 2025** | Last day for project presentations. |
| **16 June 2025** | Long Project report submission in electronic form to Teaching Office and Supervisor. |
| **20 June 2025** | Last day for supervisions. |
| **23 June 2025** | Long Project Final report submission in electronic form to Teaching Office and Supervisor. |

## Professional Conduct

MET IIB is designed as a transition from academic study to professional practice. This is reflected both in the style and content of the taught modules and in the significant focus given to industry projects and company visits. Students should remember that they are representing the University of Cambridge and the Institute for Manufacturing and at all times behave in a professional manner. The guidelines below should be observed.

### *Dress Code*

Students should be smartly turned-out and appropriately dressed for industrial projects and visits. Men should normally wear jacket and tie; a suit can be the easy option. Sensible shoes should always be worn (no high heels, sandals or trainers); other requirements may be specified by the company. During industrial projects it may be acceptable, after initial visits, to adopt a different dress code if this is the norm for the company.

### *Safety*

On all industrial project visits safety is paramount. You should pay particular attention to the following:

i. Safety precautions and notices must be observed at all times and great care should be taken to remain vigilant;

ii. Safety glasses will be issued for industrial visits and should be worn whenever appropriate. In some companies, ear protectors or protective clothing will also be necessary;

iii. On entering a company for the first time students should acquaint themselves with any specific hazards and safety requirements. Normally companies will provide a safety briefing, but if they fail to do this then students should specifically ask for guidance. It is essential that before going onto a factory floor student are aware of hazards and have appropriate protection equipment;

iv. **If students have any doubts on matters to do with Health and Safety they must stop work immediately and contact their Company and University Supervisors. Students should at all times remember they have a statutory duty to comply with all Health & Safety legislation;**

v. A "Health and Safety on Industrial Projects" checklist is given in Appendix 3 which should be used on every project and visit.

### *Intellectual Property Rights (IPR)*

Companies own the right to use all the work completed on industry projects. Students may not, without the agreement of the company, use or reveal outside the company any new ideas, designs or concepts developed during a project. They might be asked to sign a confidentiality agreement, but even without one this code of practice must be respected.

***Ethical Guidelines***

*Behaviour*

Students should demonstrate the highest standards of ethical behaviour at all times. As a minimum this means students should:

i. make every effort to perform the project to the best of their ability;
ii. discuss and agree working arrangements with the organisation and make them aware of their movements and whereabouts;
iii. be sure to keep appointments and be punctual;
iv. notify the company and the University supervisor if there are any periods of illness.

*Information*

Students who are required to collect information from other organisations should declare their association with the University **and** with the host company before asking for the information.

If information is provided in confidence, either by the host organisation or by other organisations, that confidentiality must be respected. The information must not be revealed to anyone else.

If any provider of information asks to see the project report, permission should be sought from the host organisation. If permission is granted the University Supervisor should also be informed.

*Dubious situations*

Students in any doubt about the ethicality of an action they are considering or are being asked to perform should consult their University Supervisor. If concerns remain they should contact the Industrial Projects Organiser, respectively the MET IIB Course Director.

## Expenses and travel

### Claiming of expenses

For the Michaelmas and Lent term projects, travel and other expenses can be covered by the MET teaching office. For the Long project in Easter term, all expenses should be covered by the host organisations. In cases where this is not possible, and if this has been agreed with the University Supervisor and MET Senior Administrator in advance, claims can be submitted to the IfM Teaching Office but the following very important points should be noted:

**1. All claims must be supported by receipts.**

**2. Any claim submitted more than six weeks after the expense has been incurred will not be refunded.**

**3. Students must not enter into any financial arrangements without checking with the IfM Teaching Office. There are set procedures required by the University that cannot be breached.**

## Travel arrangements

### Introduction

If travel is permitted, the IfM has the use of a fleet of vehicles for transporting students and staff to company projects and visits. The vehicles have comprehensive insurance cover when driven by accredited drivers on authorised course business only. **Under no circumstances should the vehicles be used on private business.**

### Accredited drivers

Students and staff may volunteer to be drivers of the course vehicles and may be accredited if they satisfy the following conditions:

i. have passed a university approved MiDAS driving test.
ii. hold a full driving license, in force for at least two years.
iii. have no driving convictions (excluding one speeding offence).
iv. are over 21 years of age.
v. have not been involved in any motor accidents in the past three years, either as the innocent or guilty party.

### Responsibilities of drivers

The three **essential** responsibilities of drivers are:

i. to drive with due care and attention, with the safety of their passengers in mind at all times;
ii. to comply with the requirements of the law and the Highway Code;
iii. to pay due care and attention to the condition of the vehicle in their charge.

In addition, drivers have the following operational responsibilities to:

- Collect the vehicle log book, keys and fuel purchase card from the IFM Teaching Office, normally during the afternoon of the working day before the start of the journey.
- Check basic safety items at the beginning of each journey and regularly thereafter. This applies to oil and water levels, brakes, steering, lights, and tyres.
- Report any vehicle deficiencies to the IfM Teaching Office immediately.
- Record in the log book details of each day's journey and any maintenance problems.
- Maintain a good standard of cleanliness in the vehicle.
- Purchase fuel as necessary using the card and PIN provided. Vehicles should be returned with the fuel tank full.
- Park the vehicle tidily on return to the West Cambridge carpark. Under no circumstances may vehicles be parked away from this site when in Cambridge.
- Return the vehicle log book, keys and fuel card to the IFM Teaching Office, reporting any problems verbally as well as noting them in the log book.
- To pay personally the fines for any driving offence e.g. speeding, parking or seat belt fines. **Under no circumstances will the university pay or refund the cost of such penalties**.

**Repair and Maintenance**

i. Routine maintenance and servicing is organised by the IFM Teaching Office.

ii. Emergency work necessary while the vehicle is away from Cambridge must be authorised by the IfM Teaching Office. Arrangements will normally be made for invoices to be sent to the university.

iii. Reimbursement of the cost of essential small purchases for maintenance should be claimed on an expenses claim form. Receipts must be submitted to support all claims.

**Accidents and Breakdown Emergencies**

Vehicles have a breakdown and recovery membership; details can be found in the Log Book. All accidents should be reported immediately to the IfM Teaching Office and if appropriate to the Police.

**Alternative Transport**

i. If, by prior agreement with the IfM Teaching Office only, public transport is used as an alternative to the normal fleet of vehicles the costs agreed in advance will be reimbursed. The costs will normally include bus, coach or student rail fare.

ii. Taxi's cannot be refunded without prior agreement with the IFM Teaching Office.

iii. Expenses will not normally be paid for travel within Cambridge i.e. within a 3 mile radius of Great St Mary's Church.

iv. Use of rental cars may sometimes be necessary when the IfM cars and minibuses are unavailable. The IfM Teaching Office will organise this with a local firm, but it will be the responsibility of the named designated driver to collect and return the vehicle as required under the agreement made with the car hire firm. In this case, you will have to pay for any fuel and claim payment back from the IfM Teaching Office as fuel cards will not be valid for a hire car.

**Contacts**

For all routine matters relating to vehicles, please contact the IfM Teaching Office.

## Appendix 1: MET Extension Policy and MET Penalty Policy

### Obtaining extensions or rearrangements for assessed work on the Manufacturing Engineering Tripos

#### Introduction

MET IIa and IIb consists of a range of assessed activities including examinations and coursework. Coursework has a variety of forms and may be completed both individually and in groups.

We expect students on MET IIa and MET IIb to attend all timetabled sessions and respect hand-in deadlines.

We understand that there may be valid reasons why this may not always be possible. This document sets out the conditions where extensions or rearrangements may be allowed for MET IIa and MET IIb as agreed by the Faculty board.

This policy is intended to reduce paperwork and complexity by removing the need for simple and straightforward issues to be submitted to the EAMC. It is not intended to deal with complex matters.

This policy has been updated as of the ***12th October 2023*** to align with the new University Policy on coursework extensions.

#### Policy principles for both MET IIa and MET IIb

All timetabled coursework activities are compulsory parts of the course.

In general, marks will not be awarded for activities that are not completed.

For the purposes of this document, extensions and rearrangements are defined as:

- **Extensions**: a change to the anticipated submission time for a piece of assessed work.

- **Rearrangements**: arrangement to complete an activity which is assessed or leads to a piece of assessed work at a time different to the one timetabled.

Extensions or rearrangements are feasible in specific circumstances. In general, the conditions where extensions or rearrangements can be made are:

- Extensions are possible for individual pieces of assessed work where the submission date is not close to the end of term, when there is sufficient time for subsequent examination and when there is not a subsequent piece of work which would be adversely affected by a delay.

- Rearrangements are only possible for activities which are not group based, which do not depend on availability of external resources and for which the resources are available internally at multiple times in the term.

Where ***extensions*** are feasible, students may obtain up to 7 additional days to submit the assessed work on a self-declaration basis. No tutorial support or medical evidence is required and no reason need be given. In such cases:

- The student must inform the IfM teaching office in advance, unless this is not possible and in any case within a week of the deadline.
- When the IfM teaching office is notified, students will be informed of their revised submission date.
- The student must inform their College Tutor of the request for an extension. All decisions will be copied to the student's tutor.
- Where extensions of more than 7 days are required, an application must be made to EAMC.

Where ***rearrangement*** is feasible, students must contact the IfM teaching office (MET-admin@eng.cam.ac.uk) who will then liaise with the relevant academic to identify an alternative time for the activity. If re-arrangement is not feasible and as a result the student is not awarded marks, then the student will need to consult with their tutor regarding the possibility of an application to the EAMC at a later date.

Students may not accrue more than **28** days of extensions over the academic year. Where the **28** day limit is exceeded:

- Further extension requests need to be made via EAMC.

Students may lose marks for work submitted late (without an agreed extension of rearrangement) or for non-attendance in accordance with the MET Penalty Policy at the end of this document. Students who wish to appeal these penalties must apply to the EAMC in respect of marks for missed sessions or penalties for late submission.

Decisions under this procedure will normally be made by the MET Course Director and Chair of Examiners acting on behalf of the department. On request decisions can be reviewed by the Deputy Head (Teaching) of the Department of Engineering. Students remain free to approach the EAMC if a deadline extension is not approved by the department.

**Reasonable grounds for requesting rearrangements**

**Illness**: Students may self-certify that they are ill as the reason for requesting a rearrangement (where this is feasible). A rearrangement will not be granted without self-certification. 'Illness' includes medical appointments.

**Compassionate or religious grounds**: Students may request rearrangement on compassionate or religious grounds. Examples of compassionate grounds includes attendance at a funeral of a close family member or a family or medical emergency. Attendance at a family event, such as a family holiday, wedding or graduation would not be considered compassionate grounds. Applications to rearrange timetabled activities for religious observance that usually occurs

over a restricted period (e.g. Eid al-Fitr, Shavuot, Pesach, Shivaratri, Vaisakhi) will be considered. Where observance extends over a significant period of time (e.g. Ramadan), and where it is normally expected that daily activities (including teaching) will continue as normal, applications would not be considered. Rearrangements for the purpose of holy visits, pilgrimages etc. cannot be approved.

**Interviews**: When applying for jobs, work placements or sponsorship, students may be invited for interview on days that conflict with coursework activities. Students should in the first instance seek to rearrange the interview rather than the coursework. If this proves impossible, then the student should try to rearrange the coursework. Such re-arrangements must be made in advance. Retrospective requests will not be accepted.

**Sporting and social commitments:** Coursework may not be rearranged to accommodate College sporting/social commitments or College or University training sessions. Students may be allowed to seek to rearrange coursework that conflicts with University sporting fixtures. Such re-arrangements must be made in advance. Retrospective requests will not be accepted.

**MET IIA Project and Coursework**

| Activity | Description of each element | Maximum marks associated with the activity | Mode of assessment | Ability to reschedule (if appropriate) | Ability to extend the deadline (if appropriate) |
|---|---|---|---|---|---|
| Industrial visits | Debrief presentation | 15 marks | Contribution to a group presentation | It is not possible to reschedule this group activity | NA |
| | Final presentation | 25 marks | Contribution and engagement in a group presentation | It is not possible to reschedule this group activity | None |
| CAD/CAM | CAD work | 15 marks | Coursework submission completed in a small group (2-3 students) | NA | It is not possible to extend the deadline without impacting on subsequent work. |
| | CAM work | 15 marks | Coursework submission completed in a small group (2-3 students) | NA | It is not possible to extend the deadline as it is at the end of term. |
| Production game | Pre-game report | 15 marks | Group report | NA | It is not possible to request an extension as the report must be submitted prior to the game itself |
| | Post-game reflective report | 15 marks | Individual piece of written work | NA | It is possible to request an extension |

| | | | | | |
|---|---|---|---|---|---|
| 3P3 Product Design | Portfolio submission | 60 marks | Individual piece of design work | NA | It is possible to request an extension |
| Major design project | Design Review 1 | 5 marks | Group presentation | It is not possible to reschedule these group presentations | NA |
| | Design review 1 | 10 marks | Group presentation | | |
| | Design review 2 | 15 marks | Group presentation | | |
| | Final presentation | 20 marks | A group presentation | | |
| | Design completion | 60 marks | A group submission (portfolio) | NA | It is not possible to request an extension |
| | Business plan | 20 marks | A group submission (report) | NA | It is not possible to request an extension |

## MET IIB Coursework

| Activity | Mode of Assessment | Ability to reschedule or extend deadline |
|---|---|---|
| Strategy & Marketing | Individual Assignment | 7-day extension allowed |
| TIM | Individual Assignment | 7-day extension allowed |
| DDS | Individual Assignment | 7-day extension allowed |
| AOM | Individual Assignment | 7-day extension allowed |
| PTM | Timed Assessment | No rearrangement allowed |
| | Group work | No rearrangement/extension allowed |
| Sustainable Manufacturing | Individual Assignment | 7-day extension allowed |
| Leadership and Managing People | Individual Assignment | 7-day extension allowed |
| 2-Week Project | Group Presentation | No rearrangement allowed |
| | Group Report | 7-day extension allowed |
| 4-week Project | Group Presentation | No rearrangement allowed |
| | Group Report | No extension allowed |
| Long Project | Individual Presentation | No rearrangement allowed |
| | Individual Report | No extension allowed |
| Robot Lab | Lab work | No rearrangement allowed – attendance is compulsory |
| | Technical Report | No extension allowed |
| | Final Presentation | No extension/rearrangement allowed |
| | Final Integrated Solution & Demonstration | No extension/rearrangement allowed |
| | Individual Report | 7-day extension allowed |

**MET Penalty Policy**

Work submitted after an agreed deadline (either the original deadline or an agreed extension), will be assessed on submission as normal. It will be marked as if submitted on time. A penalty will subsequently be applied which will be a reduction of 20% of the assessed grade for each week (or part week) that the work is late as outlined below.

| Original mark (%) | 1 week late | 2 weeks late | 3 weeks late |
|---|---|---|---|
| 80.0 | 64.0 | 38.4 | 15.4 |
| 75.0 | 60.0 | 36.0 | 14.4 |
| 70.0 | 56.0 | 33.6 | 13.4 |
| 65.0 | 52.0 | 31.2 | 12.5 |
| 60.0 | 48.0 | 28.8 | 11.5 |
| 55.0 | 44.0 | 26.4 | 10.6 |
| 50.0 | 40.0 | 24.0 | 9.6 |
| 45.0 | 36.0 | 21.6 | 8.6 |

Where an extension was not feasible, the piece of work will either not be assessed (if no work is submitted) or the student will be assessed on the work they have completed up to the submission date.

Where students miss activities which cannot be rescheduled, students will not gain the marks associated with those activities.

Students are able to submit an application to the EAMC where marks have been lost due to activities which cannot be rescheduled or where an extension is not available.

Your College Tutor can assist you in making an application to the EAMC. You should note that EAMC approves allowances in the case of illness or other "grave cause."

This should be done after marks have been released, normally at the end of Easter term. You should not make applications piecemeal throughout the year. You should also note that the EAMC typically only considers cases which would lead to change in your degree classification.

Any application to the EAMC will be reliant on the evidence submitted to support the application and therefore you should keep evidence, including any emails confirming that extensions or rearrangements were not possible and notes of any interactions that you had with your GP, Tutor or College Nurse at the time to confirm illness. You should also keep evidence of any positive COVID test etc.

## Appendix 2: University of Cambridge General Board Statement on Plagiarism

The General Board, with the agreement of the Board of Examinations and the Board of Graduate Studies, has issued this guidance for the information of candidates, Examiners and Supervisors. It may be supplemented by course-specific guidance from Faculties and Departments.

Plagiarism is defined as submitting as one's own work that which derives in part or in its entirety from the work of others without due acknowledgement. It is both poor scholarship and a breach of academic integrity.

Examples of plagiarism include **copying** (using another person's language and/or ideas as if they are a candidate's own), by:

- **quoting verbatim** another person's work without due acknowledgement of the source;
- **paraphrasing** another person's work by changing some of the words, or the order of the words, without due acknowledgement of the source;
- **using ideas** taken from someone else without reference to the originator;
- **cutting and pasting** from the Internet to make a pastiche of online sources;
- **submitting someone else's work** as part of a candidate's own without identifying clearly who did the work. For example, buying or commissioning work via professional agencies such as 'essay banks' or 'paper mills', or not attributing research contributed by others to a joint project.

Plagiarism might also arise from **colluding** with another person, including another candidate, other than as permitted for joint project work (i.e. where collaboration is concealed or has been forbidden). A candidate should include a general acknowledgement where he or she has received substantial help, for example with the language and style of a piece of written work.

Plagiarism can occur in respect to all types of sources and media:

- text, illustrations, musical quotations, mathematical derivations, computer code, etc;
- material downloaded from websites or drawn from manuscripts or other media;
- published and unpublished material, including lecture handouts and other students' work.

Acceptable means of acknowledging the work of others (by referencing, in footnotes, or otherwise) vary according to the subject matter and mode of assessment. Faculties or Departments should issue written guidance on the relevant scholarly conventions for submitted work, and also make it clear to candidates what level of acknowledgement might be expected in written examinations. Candidates are required to familiarize themselves with this guidance, to follow it in all work submitted for assessment, and may be required to sign a declaration to that effect. If a candidate has any outstanding queries, clarification should be sought from her or his Director of Studies, Course Director or Supervisor as appropriate.

Failure to conform to the expected standards of scholarship (e.g. by not referencing sources) in examinations may affect the mark given to the candidate's work. In addition, suspected cases of the use of unfair means (of which plagiarism is one form) will be investigated and may be brought to one of the University's Courts. The Courts have wide powers to discipline those

found guilty of using unfair means in an examination, including depriving such persons of membership of the University.

The University's plagiarism and good academic practice website (www.cam.ac.uk/plagiarism) provides more information and guidance.

**Plagiarism and good academic practice: your responsibilities**

If, after reading the guidance, you have any outstanding queries you should seek clarification at the earliest opportunity from your Director of Studies or supervisor.

**Sources of further information and support**

*The University's plagiarism website:*

www.cam.ac.uk/plagiarism

*Department's plagiarism advice:*

http://teaching.eng.cam.ac.uk/node/526

## Appendix 3: Sample MET IIB Forms

**Industrial Project Michaelmas project – University Supervisor Project Assessment**
**Industrial Project Lent project – University Supervisor Project Assessment**
**Industrial Project Easter project – University Supervisor Project Assessment**
**Industrial Project – Company Supervisor feedback form**
**Health and Safety on Industrial Projects**

# Michaelmas term: 2 Week Project – University Supervisor Project Assessment

**MANUFACTURING ENGINEERING TRIPOS**

**Confidential METIIB Industrial Project Assessment (2Week)**

**Student:** _____
**Company:** _____
**Assessed By:** _____
**Date:** _____

| | Supervisor's Mark (%) | Assessor's Mark (%) | Agreed Mark (%) |
|---|---|---|---|

**A. Success in Meeting Objectives**
*How well have the stated objectives been met, taking into account the difficulty of the task and the timescale of the project? How were the results of the project received by the "client"?*

**Justification for mark:**

**B. Quality of Project Approach**
*Was the project tackled in a professional manner? Were appropriate analytical tools used? Were the technical aspects of the project adequately handled? Were there any novel ideas or approaches?*

**Justification for mark:**

**C. Oral Presentation of Results**
*Were the results presented in a clear and competent way? Was good use made of visual aids? Was the presenter audible, enthusiastic and articulate? Were questions well handled?*

**Justification for mark:**

**D. Structure and Style of Interim Report**
*Was the report well-structured and written in clear, understandable English? Were the departmental Guidelines adhered to? Were the style and structure appropriate for a technical report? Were the sections and subsections logically organised? Was there a good summary? Was appropriate use made of appendices?*

**Justification for mark:**

**E. Interim Report Content**
*Did the report convey a full and accurate 'picture' of the project? Did it contain a thorough description of the relevant methods and justify their selection, as well as analysis and the relevant supporting data? Were the boundaries of the project and all relevant assumptions clearly identified? Were there systematically derived recommendations and sensible conclusions?*

**Justification for mark:**

| | Supervisor's mark % | Agreed mark % |
|---|---|---|
| **Overall Mark (Weight factors as shown)** *(0.3xA) + (0.2xB) + (0.15xC) + (0.15xD) + (0.2xE).* *(This sheet will be kept confidential – i.e., it is not copied to students or companies.)* | **0.00** | **0.00** |

**Note: supervisors should not give any indicative marks / grades to the students**

# Lent term: 4 Week – University Supervisor Project Assessment

**MANUFACTURING ENGINEERING TRIPOS**

**Confidential METIIB Industrial Project Assessment (4 Week)**

| | |
|---|---|
| **Student:** | |
| **Company:** | |
| **Assessed By:** | |
| **Date:** | |

| | Supervisor's Mark (%) | Assessor's Mark (%) | Agreed Mark (%) |
|---|---|---|---|
| **A. Success in Meeting Objectives**<br>*How well have the stated objectives been met, taking into account the difficulty of the task and the timescale of the project? How were the results of the project received by the "client"?*<br>**Justification for mark:** | | | |
| **B. Quality of Project Approach**<br>*Was the project tackled in a professional manner? Were appropriate analytical tools used? Were the technical aspects of the project adequately handled? Were there any novel ideas or approaches?*<br>**Justification for mark:** | | | |
| **C. Oral Presentation of Results**<br>*Were the results presented in a clear and competent way? Was good use made of visual aids? Was the presenter audible, enthusiastic and articulate? Were questions well handled?*<br>**Justification for mark:** | | | |
| **D. Structure and Style of Interim Report**<br>*Was the report well-structured and written in clear, understandable English? Were the departmental Guidelines adhered to? Were the style and structure appropriate for a technical report? Were the sections and subsections logically organised? Was there a good summary? Was appropriate use made of appendices?*<br>**Justification for mark:** | | | |
| **E. Interim Report Content**<br>*Did the report convey a full and accurate 'picture' of the project? Did it contain a thorough description of the relevant methods and justify their selection, as well as analysis and the relevant supporting data? Were the boundaries of the project and all relevant assumptions clearly identified? Were there systematically derived recommendations and sensible conclusions?*<br>**Justification for mark:** | | | |

| | Supervisor's mark % | Agreed mark % |
|---|---|---|
| **Overall Mark (Weight factors as shown)**<br>*(0.3xA) + (0.2xB) + (0.15xC) + (0.15xD) + (0.2xE).*<br>*(This sheet will be kept confidential – i.e., it is not copied to students or companies.)* | **0.00** | **0.00** |

**Note: supervisors should not give any indicative marks / grades to the students**

# Easter term: Long Project – University Supervisor Project Assessment

**MANUFACTURING ENGINEERING TRIPOS**

**Confidential MET IIB Industrial Project Assessment (Long)**

| | |
|---|---|
| **Student:** | |
| **Company:** | |
| **Assessed By:** | |
| **Date:** | |

| | Supervisor's Mark (%) | Assessor's Mark (%) | Agreed Mark (%) |
|---|---|---|---|

**A. Success in Meeting Objectives**

*How well have the stated objectives been met, taking into account the difficulty of the task and the timescale of the project? How were the results of the project received by the "client"?*

**Justification for mark:**

**B. Quality of Project Approach**

*Was the project tackled in a professional manner? Were appropriate analytical tools used? Were the technical aspects of the project adequately handled? Were there any novel ideas or approaches?*

**Justification for mark:**

**C. Oral Presentation of Results**

*Were the results presented in a clear and competent way? Was good use made of visual aids? Was the presenter audible, enthusiastic and articulate? Were questions well handled?*

**Justification for mark:**

**D. Structure and Style of Final Report**

*Was the report well-structured and written in clear, understandable English? Were the departmental Guidelines adhered to? Were the style and structure appropriate for a technical report? Were the sections and subsections logically organised? Was there a good summary? Was appropriate use made of appendices?*

**Justification for mark:**

**E. Final Report Content**

*Did the report convey a full and accurate 'picture' of the project? Did it contain a thorough description of the relevant methods and justify their selection, as well as analysis and the relevant supporting data? Were the boundaries of the project and all relevant assumptions clearly identified? Were there systematically derived recommendations and sensible conclusions?*

**Justification for mark:**

| | Supervisor's mark % | Agreed mark % |
|---|---|---|
| **Overall Mark (Weight factors as shown)**<br>*(0.3xA) + (0.2xB) + (0.15xC) + (0.15xD) + (0.2xE).*<br>*(This sheet will be kept confidential – i.e., it is not copied to students or companies.)* | **0.00** | **0.00** |

**Note: supervisors should not give any indicative marks / grades to the students**

## Industrial Project – Company Supervisor feedback form

CAMBRIDGE UNIVERSITY ENGINEERING DEPARTMENT
MANUFACTURING ENGINEERING TRIPOS
**Industrial Project – company supervisor's feedback**

| |
|---|
| Host Company: Location:<br><br>Project Title:<br><br>Company Supervisor: University Supervisor: |
| 1. Please comment on the presentation of results.<br>Is the report clear, structured, accurate and well presented? |
| 2. Please comment on how the project team approached the project.<br>Were the investigations sound? Did they develop a 'feel' for the job? |
| 3. Please comment on the way the project was implemented.<br>How well were the objectives met? Were the results useful to the company? |
| 4. Additional comments |
| I confirm that unless indicated below the report is in **no way confidential** and that a bound report is **not** required<br><br>Report is confidential ☐ Bound report required ☐<br><br>Signed…… Date……<br>Company supervisor<br><br>University Supervisor's response |

***Health and Safety***

*MET students are given health and safety briefing at the start of the course. The following safety checklist and reminders of Section 7 & 8 of the health and safety at work Act 1974 are given as guidance for the company H&S briefing at the commencement of a project. Specific company policies and hazards will also need to be included.*

| PROJECT PLACEMENT SAFETY INDUCTION CHECKLIST | | |
|---|---|---|
| 1 | MEANS OF FIRE EVACUATION FROM WORK/BUILDING | |
| 2 | FIRE EVACUATION AND ASSEMBLY POINTS | |
| 3 | LOCATION OF FIRE ALARM CALL POINTS AND EXTINGUISHERS | |
| 4 | FIRST AIDER AND FIRST AID FACILITIES, ACCIDENT REPORTING | |
| 5 | PERSONAL PROTECTIVE EQUIPMENT WHERE USED (WITH INSTRUCTIONS WHERE REQUIRED). DUTY TO REPORT ANY DAMANGE, LOSS OR DEFECTS OF ISSUED ITEMS TO LOCAL SUPERVISOR | |
| 6 | HOUSEKEEPING, TOILET FACILTIES, LOCATIONS WHERE EATING AND DRINKING ARE PERMITTED | |
| 7 | OBSERVATION OF SAFETY SIGNS e.g. NOISE AREAS, SAFETY SPECS etc | |
| 8 | TRANSPORT MOVEMENT ON SITE e.g. FORK LIFT TRUCKS | |
| 9 | KNOWN LOCAL SAFETY HAZARDS APPLICATION TO A PROCESS OR PROCEDURE | |
| 10 | CHECK IF RELEVANT RISK AND C.O.S.H | |
| 11 | PERMITS TO OPERATE/WORK WHERE APPLICABLE | |
| 12 | IF THERE IS ANYTHING ABOUT HEALTH AND SAFETY LEFT IN DOUBT THEN ASK – NEVER ASSUME | |

*Under section 7 and 8 of the Act all employees have the duty as follows*

***Section 7***

*(a) It shall be the duty of every employee while at work to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions at work; and*

*(b) as regards any duty or requirement imposed on his employer or any other person by or under any of the relevant statutory provisions, to co-operate with him so far as is necessary to enable that duty or requirement to be performed or complied with.*

***Section 8***

*No person shall intentionally or recklessly interfere with or misuse anything provided in the interests of health, safety or welfare in pursuance of any of the relevant statutory provisions.*

*It is important that you ensure all items on the checklist and any other local health and safety concerns are explained to and understood by the students. In particular, please emphasise item 12.*

2

## Appendix 4: MET Report Template and Style Guide

An example of the layout and style required for a MET project report is given on the following pages.

UNIVERSITY OF CAMBRIDGE

Institute for Manufacturing

# Report Title in this box

Report Number: MET/## - ## - ##

Company Name

Supervisor: Supervisor's name

Author Name

Date

## Executive Summary

The purpose of the Executive Summary is to provide a succinct overview of the project. It should be brief enough that even the busiest executive will feel able to scan it, but complete enough to provide a complete picture of the project. It must never be more than one page in length. In it, you should summarise:

- The aims of the project;
- Your main conclusions;
- Your action points.

You can use bullets, which help to keep it short and to emphasise the points you particularly want to get across. But, reading pages full of bullets is tiresome, and so prose should be used wherever possible.

Remember that hardly anyone (except the Cambridge and the Industrial project supervisors) will sit down and read the project cover-to-cover. Most people will pick it up to read your words of wisdom on a particular topic, and if you are very lucky they may read the executive summary or the conclusions as well.

The implications of this for the way you write the report are:

- Some repetition is desirable. Your conclusions and recommendations may appear up to three times: in the executive summary; in the section from which they derive (where full explanations will be given), and in the conclusions section at the end of the report.
- Each section should be quite self-contained, with an introductory sentence or paragraph outlining what will be covered, and conclusions and recommendations relating to the section.

*Author name*

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1.1 Each section should be initialled ..... **Error! Bookmark not defined.**

2.0 Guidance on formatting ..... 97

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3.0 References ..... 99

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In word, you can create a table of contents automatically, providing you have used appropriate 'styles' for section headings. But this is not fool proof, and very often the list is wrong. ALWAYS check this to ensure it is correct.

When you make changes to a document, if the contents page is automatic, then you must 'update field' in order to change it.

## 1.0 Introduction (Heading 1, Bold, Calibri 12pt, 0pt before, 6pt after)

This document describes the standard formatting required for all reports to be submitted. This must be adhered to. The easiest way to do this is to download and use this template as provided in Moodle.

The body text of the report is written in 12pt Cambria, with 3 points before and 6 points after each paragraph. Line spacing is 1.5. This is the NORMAL font style.

## 1.1 Report title page (Heading 2, Bold, Calibri 14pt, 12pt before, 6pt after)

The report title should be visible through the hole in the front cover. There should be no page number on the title page. Page numbering starts at 1 with the executive summary.

On the title page, should be the report title, the author's names and where appropriate the supervisor's name and the company name. The submission date should also be included.

## 2.0 Guidance on formatting

The way you structure the content for the main part of the report will vary depending on the project. A project which focuses on a narrow set of issues may call for results to be presented in one large chapter, with subsections. Alternatively, you may want to have several shorter chapters. Use your common sense, and discuss with your supervisor if in doubt.

Typical content would include:

- Company Background: A brief description of company: size, location, sector, important features of operation etc. (Bulleted List, Cambria, 12pt, 3pt before, 6pt after, 1.5 line spacing).
- Description of project: What is it that is trying to be achieved
- Why is the project being done?
- What does the company want to achieve?
- Bulleted List:

The report needs to be as brief as possible, but must convey the important messages to the company. Deciding what should be included and what can be left out is a very important part of the whole report-writing process.

The guideline of 4000 words means that you must be selective, and use your judgement. Experience shows that a report which is longer than this benefits from being cut. This results in a report which is better focused and better thought-through, which is more likely to be read, and hence more likely to be useful.

## 2.1 Subsection

Use subsections when they are a sub-part of the main argument being made in the main section. The margins for all sub-sections are the same as for major sections. To keep things neat and easy to read, make sure you keep headings with their sections! Check just before you print out the final version of the document.

### 2.1.1 Sub-sub-sections (Heading 3, Calibri, Italic, 14 point, 12 pt before, 6 pt after)

Use two levels of indentations if really needed. An argument becomes near impossible to follow if further levels of indentation are used.

(i) **Sub-sub-sub**: After that it gets difficult counting numerals, so best to use some other numbering system – which could be Roman lower-case numerals, as here, or (a), or just bullets. The text is now indented, with bold text used as required for clarity. (Sub-sub-sub, Cambria, 12pt, indented)

## 2.2 Tables, Figures etc.

Here is a typical table. It could be labelled Table 1. Please refer to tables and figures in the text before they appear in the document. You must give all tables and figures a proper descriptive title, as in the examples below.

Tables should adhere to the visual styles given in Table 1. The font 'style' is 'Table text'. The font for the title is 'Figure'. Please make the table fit the page.

| Reason | % of total |
|---|---|
| Slept in | 48.5 |
| Hung over | 48.5 |
| Moral objection | 1.0 |
| Mislaid bicycle/puncture | 1.0 |
| Really good reason | 1.0 |

*Table 1: Reasons for missing lectures for last year's MET2 class. Origin: A. Mole (2005).*

Figure 1 shows another common type of figure. Usually, you will number figures and tables in order from the start of the report. In a long report, or one divided into several chapters, you may instead number figures within a chapter. For example, in chapter 2 the figures might be numbered 2.1, 2.2 etc.

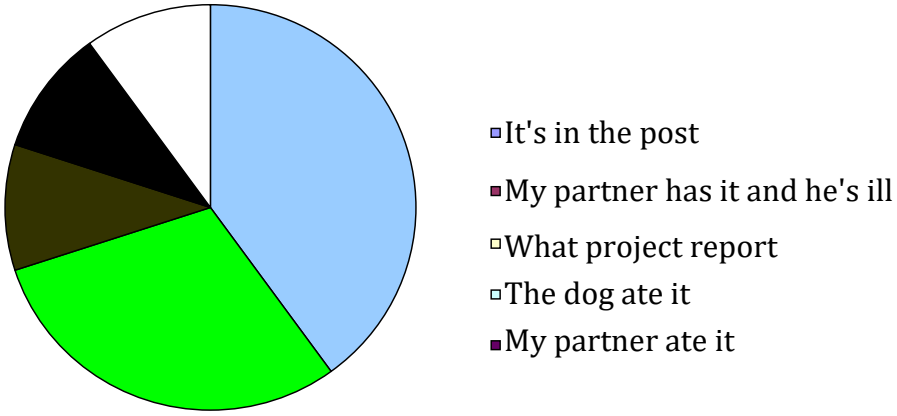


*Figure1: Reasons given for late hand-in of project reports. Origin: MET Office (2005).*

## 3.0 References

All the information you supply must be fully referenced, so that it is traceable. This includes oral comments from people in the company, as well as the more usual books, journals, websites. There are many ways of citing references, and all are acceptable. Important is that you use the same style consistently throughout the report. The use of a reference management software is strongly advised (e.g. Mendeley, Zotero, Endnote) and can already be helpful to organize the evidence collection during the project.

First, where a reference arises in your text, it is essential that you cite the authors and publication date in the text. Some examples:

- Kimberley and Rogers (1999) claim that eggs are better than bacon.
- Eggs have been described by some authors as being better than bacon (e.g. Kimberley and Rogers 1999, Smith and Jones 2000).
- Eggs have been demonstrated experimentally as being better than bacon amongst middle income earners in Coventry (Blacksmith 2012).

- Quote a superscript number[1] or number in brackets [1].

Wherever you use a reference, you must provide the full reference in a list of references at the end of the document.

While referencing usually refers to citing books, reports and articles available in the public domain you will most likely use and thus need to cite internal company documents, but also interviews.

At the end of the report, you should have a section headed "REFERENCES" and all of the references used in the document should be listed in detail in alphabetical order. A sub-section may include a numbered list of people you have interviewed, so that these numbers can be referenced in the text.

Examples of referencing styles for books, journal papers, conference papers, websites and reports are provided below:

***Journal or conference papers***

Will Smith & Ken Rogers, "Automotive Engineer", February 1999, pp 44-56; [Font style 'Reference', Cambria 12 pt, 3pt before 6 pt after, 1.2 line spacing, 0.5 hanging indent]

Borja de Mozota, B. (2002). "Design and competitive edge: a model for management excellence in European SMEs." Design Management Journal 2(1): pp. 88 - 104.

***Books***

Bruce, M. and J. Bessant (2002). Design in Business: Strategic Innovation Through Design. New York, Financial Times/Prentice Hall.

***Reports/Websites***

BSI (1995). BS 7000-10:1995 Design Management Systems - Part 2. London, British Standards Institute.

CIS, (2007), The CIS questionnaire and other details can be found online at http://www.dius.gov.uk/science/science_and_innovation_analysis/cis.

Haskel J, Clayton T, Goodridge P, et al, (2009), Innovation, knowledge spending and productivity growth in the UK: interim report for NESTA 'Innovation Index' project, Innovation, knowledge spending and productivity growth in the UK: interim report for NESTA 'Innovation Index' project, 2010/02, Imperial College Business School

## 4.0 Report submission

At hand in, you must submit:

- An electronic pdf version, with a suitably chosen file name. A suggested file name convention is described below. This should be submitted by email to IfM Teaching Office (met-admin@eng.cam.ac.uk ).

Naming a DRAFT report:

- Smith 2WP Draft 24-9-13.doc
- Replace 'Smith' with your surname(s)
- Replace '2WP' with either IP (Induction Project), 2WP (2 Week project), 4WP (4 week project), LP (Long project)
- Replace date with the submission date

A copy of your DRAFT goes to your supervisor for comment, and you will have a supervision within a few days of submission. There are normally some corrections to be made. After changes/corrections have been completed, hand in a final electronic copy to the IfM Teaching Office (met-admin@eng.cam.ac.uk ).

Naming a FINAL report:

- Smith 2WP FINAL 25-9-13.doc
- Replace as above.

Your report should be produced using A4 pages only so that it can be fed through the automatic sheet-feeder on a photocopier. If anything cannot be treated in this way (outsize figures etc) you must seek advice and approval first.

The FINAL, corrected report is immediately sent off to the company for comment, and once this has been received copies of the report are bound and distributed.

## 5.0 Conclusion

If you have followed the advice in this document, you should be able to produce a report in an acceptable format! Suggestions for improvements are welcome.