UNSW AUSTRALIA

Course Outline

Semester 1, 2015

Never Stand Still | Faculty of Engineering | School of Mechanical and Manufacturing Engineering

MANF3100

PRODUCT AND MANUFACTURING DESIGN

CONTENTS

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COURSE OUTLINE

1. STAFF CONTACT DETAILS:

Course coordinator: Erik van Voorthuysen
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Lecturers: Dr Alex Green, Mr Corey Martin, Erik van Voorthuysen

Consultation concerning this course is available immediately after the classes. Direct consultation is preferred.

2. COURSE DETAILS

Lecture Times and Locations

Wednesday 0900-1200 Red Centre West M010 (Lecture)
Wednesday 1200-1300 Willis Annexe 116C UG Lab (K-J18-116C)

Units of credit

This is a 6 unit-of-credit (UoC) course, and involves 4 hours per week (h/w) of face-to-face contact.

The UNSW website states “The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work.”

For a standard 24 UoC in the session, this means 600 hours, spread over an effective 15 weeks of the session (thirteen weeks plus stuvac plus one effective exam week), or 40 hours per week, for an average student aiming for a credit grade. Various factors, such as your own ability, your target grade, etc., will influence the time needed in your case. Some students spend much more than 40 h/w, but you should aim for not less than 40 h/w on coursework for 24 UoC.

This means that you should aim to spend not less than about 10 h/w on this course, i.e. an additional 6 h/w of your own time. This should be spent in making sure that

you understand the lecture material, completing the set assignments, further reading about the course material, and revising and learning for the quizzes.

There is no parallel teaching in this course.

Summary of the course

This course focuses on making certain that a complex design, whether mechanical, mechatronic or aerospace, can also be successfully manufactured, from a quality as well as cost perspective. The key concept is the ability to translate functional requirements of a design into detailed subsystem-, equipment- and ultimately component-level specifications. These design-related specifications are then further developed into process specifications and ultimately support process selection and planning. Whereas the course has a strong focus on processing and transformation technology, the economic analysis of manufacturing processes is also an important part of the course. The reason for this is that around 70% of manufacturing costs, including material, processing and assembly, are determined by design specifications before the product even hits the factory floor. The remaining 30% of costs are determined by operational decisions including machine selection, process planning, scheduling, routing and so on.

Topics include an overview of transformation processes and related cost and quality drivers, design for manufacturing related methodologies including quality function deployment (QFD), concurrent design, lifecycle design, value analysis, value engineering, robust design, axiomatic design and tolerance analysis. The course also introduces basic jig and fixture design for different levels of automation and manufacturing processes as well as an introduction to metrology for manufacturing engineers. Modern CAD/CAM systems contain sophisticated functionality and modules that automate some of the analysis and design functions with respect to process planning and even jig design. We have planned for an industry expert to give a guest lecture on this topic.

The course will combine lectures with practical case studies that require the theory taught to be applied to actual product designs and prototypes. Students have the option to bring their own examples and case studies into the course or alternatively select one of the recently developed designs provided in class.

Aims of the course

The course aims to develop you into a skilled and all-rounded design engineer able to carry out and manage the key design processes in parallel and concurrently. Design is inherently complex and a systematic, yet flexible, agile and interdisciplinary approach is required to bring product to the market successfully and in less time. The course teaches this approach, based on global best-practice methodologies, and

incorporates case studies and projects, even your own designs and plans, to apply these methodologies and become proficient at them.

Student learning outcomes

At the conclusion of the course it is expected that you will be able to:

1) Understand and apply systematic design principles including:
    - Quality Function Deployment (QFD)
    - VDI-2206 and 2221 Design Standards
    - Axiomatic and robust design principles
    - Value analysis and value engineering methods.
2) Analyze and characterize manufacturing transformation processes in terms of key technical and economic drivers and factors.
3) Integrate the knowledge gained in (1) and (2) to make appropriate product design as well as transformation process selection and specification decisions.
4) Be able to integrate this information and design intent into CAD/CAM systems.
5) Develop an engineering design or prototype into a design that can be effectively and efficiently manufactured to meet customer as well as OEM requirements.
6) Understand the principles of manufacturing economics as it applies to material transformation processes as well as assembly processes and to apply economic analysis to develop cost and production estimates for your design.
7) Understand the fundamentals and key technologies used in manufacturing measurement and how this is used to support and guarantee successful manufacturing outcomes.
8) Understand the basic principles of jig and fixture design as a key enabling factor in the manufacture of product at different levels of volume and with different transformation technologies.

Graduate attributes

UNSW's graduate attributes are shown at
https://my.unsw.edu.au/student/atoz/GraduateAttributes.html

and are stated as:

Scholars who are:

1. understanding of their discipline in its interdisciplinary context
2. capable of independent and collaborative enquiry
3. rigorous in their analysis, critique, and reflection
4. able to apply their knowledge and skills to solving problems
5. ethical practitioners

6. capable of effective communication
7. information literate
8. digitally literate

Leaders who are:

9. enterprising, innovative and creative
10. capable of initiating as well as embracing change
11. collaborative team workers

Professionals who are:

12. capable of independent, self-directed practice
13. capable of lifelong learning
14. capable of operating within an agreed Code of Practice

Global Citizens who are:

15. capable of applying their discipline in local, national and international contexts
16. culturally aware and capable of respecting diversity and acting in socially just/responsible ways
17. capable of environmental responsibility

A statement of broad graduate attributes has meaning when expressed in the context of the discipline. The graduate attributes contextualised for engineering are shown at: http://teaching.unsw.edu.au/sites/default/files/upload-files/GradAttrEng.pdf

In this course, you will be encouraged to develop Graduate Attributes 1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15 and 17 by undertaking the selected activities and knowledge content. These attributes will be assessed within the prescribed assessment tasks, as shown in the assessment table on Page 7.

3. RATIONALE FOR INCLUSION OF CONTENT AND TEACHING APPROACH

This course is included to build on knowledge gained from core courses undertaken in mechanical engineering design by developing the ability and skills to prepare a design or product for manufacture. Mechanical engineering design is rarely done in isolation, rather it is done concurrently with other key processes including design for manufacturing, quality management, operations and costing and so on. This course focuses specifically on key design for manufacturing methodologies, process selection, planning and costing and enabling technologies. In combination with mechanical engineering design courses, the knowledge and capabilities gained from this course will allow you to become a skilled and all-rounded design engineer. This course is also designed to support projects that you are working on or intend to work on during or after your degree with us. We give you the opportunity to bring your

own case-studies and projects into the course and use these to learn the course material but also use the course material to substantially advance your ideas.

Effective learning is supported when you are actively engaged in the learning process and by a climate of enquiry, and these are both an integral part of the lectures and practica.

You become more engaged in the learning process if you can see the relevance of your studies to professional, disciplinary and/or personal contexts, and the relevance is shown in the lectures and assignments by way of examples drawn from industrial situations as well as designs that are discussed in class.

Dialogue is encouraged between you, others in the class and the lecturers. Diversity of experiences is acknowledged, as some students in each class have prior experience. Your experiences are drawn on to illustrate various aspects, and this helps to increase your motivation and engagement.

Since you will work closely with your demonstrators, laboratory staff and colleagues, you will have almost instant feedback and discussion and this greatly enhances the learning experience.

4. TEACHING STRATEGIES

Lectures in the course are designed to cover the terminology and core concepts and theories in the area of design for manufacturing. They do not simply reiterate the texts, but build on the lecture topics using examples taken directly from industry to show how the theory is applied in practice and the details of when, where and how it should be applied.

Practica are designed to provide you with feedback and discussion on the assignments, and to investigate problem areas in greater depth to ensure that you understand the application.

Teaching Strategies and their rationale

This course will be presented using PowerPoint presentations as well as case studies and real-life designs that exist as prototypes and need to be prepared and likely redesigned for manufacture. The material will be presented in the lecture and the student is expected to actively participate in discussion, analysis and design. Assignments to develop the understanding of the key methodologies and theories and how to apply them will be provided as part of the course. There will be quizzes to support the learning experience, but no final exam.

Suggested approaches to learning in the course

Suggested approaches to learning in this course include:

- Careful reading, discussion and understanding of the material presented in lectures.
- Additional reading on and about the material presented in lectures to broaden the knowledge base.
- Paying attention throughout the lectures/practica, and asking questions when anything is not understood.
- Conscientiously working through assignments.
- Learning of the lecture material in preparation for quizzes.

Student-centered and self-directed learning (expectations of the students)

This course involves six hours per week of face-to-face contact, and it is expected that you will put in, on average, an additional four hours per week of your own time. This time should be spent in revising lecture material and further reading, completing assignments, and revising and learning for the quizzes.

Expected learning outcomes; their association with the teaching strategies and with the suggested approaches to learning

The lectures are designed to teach you the underlying theory and key methodologies centered on design for manufacturing, transformation process selection, costing and measurement. These methodologies are state-of-the-art and used by leading industrials. The assignments are designed to use these methodologies on real case-studies and give you the confidence and ability to make important design and manufacturing decisions. This helps to prepare you for a rewarding career in this field.

We provide some very interesting designs for you to work on, but if you have your own design that you want to develop than we are more than happy to accommodate that as well. The course has been designed to support academic learning, by understanding the theory and philosophy of design for manufacturing, but also to support developing practical skills that industry needs.

5. ASSESSMENT

General

You are assessed by way of assignments, quizzes, and presentations. There is no end-of-semester examination. Quizzes involve both calculations and descriptive material.

Quizzes x 3	30%	(Graduate Attributes: 1, 2, 3 and 4)
Assignment Part I	30%	(Graduate Attributes: 1, 2, 3, 4, 7, 8, 13,14, 15, 17)
Assignment Part II	40%	(Graduate Attributes: 1, 2, 3, 4, 7, 8, 13,14, 15, 17)
Overall mark for course	**100%**	

The dates for the quizzes and assignments will be provided on Moodle as the course progresses. The assessments are designed to bolster your understanding of the material being presented and focus on the key learning points. The quizzes will test the understanding of the sections being presented while the assignments will allow you to apply the concepts learnt in the course.

Assignments

The assignments will be posted on Moodle and announcements will be made about due dates. Completed assignments will be handed in hard copy by the end of the week the assignment is due. The assignments support the learning outcomes by incorporating an appropriate mix of analysis techniques, design methodologies, fact based data analysis that support the design of appropriate solutions. The assignments also support collaborative team work and integration of different ideas and components into an overall coherent product development strategy.

The School guidelines recommend that late submissions incur a penalty of 10% of the total marks awarded for each calendar day the assignment is late. For example, if you received a mark of 40 out of 50 for an assignment that you handed in 2 days late you would receive a penalty of 8 marks and your mark would be reduced to 32. If the same assignment were handed in 4 days late the mark would be reduced to 24. An extension may only be granted in exceptional circumstances. Where an assessment task is worth less than 20% of the total course mark and you have a compelling reason for being unable to submit your work on time, you must seek approval for an extension from the course convenor before the due date. Special consideration for

assessment tasks of 20% or greater must be processed through: https://student.unsw.edu.au/special-consideration

Please note that late penalties are at the discretion of the course convenor and in some cases late work may not be assessed. Please carefully check course outlines for more detailed information regarding late penalties.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Submission of Assignments

Each of you will be assigned to a major project. You can undertake this by yourself or in a team of two. The project will revolve around an existing and functioning prototype design. This design can be yours or ours. The project is to develop this prototype into a design that can be successfully manufactured at a certain volume, level of quality, level of performance, cost and so on.

The assignment consists of two parts. Part I deals with the analysis of functionality, establishment of design specifications and development of process specifications. Part II then is based on the outcome of Part I and involves the selection of material, transformation processes and the estimation of production and costing data.

Each part of the assignment requires a write-up and these are due in week 8 and week 13.

You need to ensure that you use both an appropriate writing style as well as professional formatting and editing of style and content in your report.

Criteria for Marking

The following criteria will be used to grade assignments:

- Analysis and evaluation of requirements by integrating knowledge and methods learned in lectures and practica.
- Sentences in clear and plain English—this includes correct grammar, spelling and punctuation
- Correct referencing in accordance with the prescribed citation and style guide
- Appropriateness of analytical techniques and methodologies used
- Accuracy of numerical answers
- Evidence of quality data and analysis-based decision making
- All working shown
- Use of diagrams, where appropriate, to support or illustrate the calculations

- Use of graphs, were appropriate, to support or illustrate the calculations
- Use of tables, where appropriate, to support or shorten the calculations
- Neatness

6. ACADEMIC HONESTY AND PLAGIARISM

Plagiarism is using the words or ideas of others and presenting them as your own. Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a booklet which provides essential information for avoiding plagiarism: https://my.unsw.edu.au/student/academiclife/Plagiarism.pdf

There is a range of resources to support students to avoid plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one. Information is available on the dedicated website Plagiarism and Academic Integrity website: http://www.lc.unsw.edu.au/plagiarism/index.html

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks. If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here: http://www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Further information on School policy and procedures in the event of plagiarism is presented in a School handout, Administrative Matters for All Courses, available on the School website.

7. COURSE SCHEDULE

Week	Topic	
1	The Economic Case for Manufacturing Process Selection Design Theory, QFD, Developing Functional Requirements, V-Model design theory, Axiomatic Design, Concurrent Design	evv
2	Process and Material Selection Methods Process Information Maps, Identifying Critical Process Parameters Practica/Lab: Project introduction	ag
3	Design for Assembly (DFA), Design for Manufacturing (DFM), Design for Reliability, Design for Sustainability Practica/Lab: Project selection, scoping, developing functional requirements	ag
4	Introduction to CAD/CAM with SolidWorks and SolidCam	ag
5	Economics of Industrial Machinery and Process Equipment, Component and Assembly Costing Methods Value Analysis, Value Engineering, Robust Design, Process Capability	evv
6	Casting and Forming, Machining Processes Practica/Lab: CNC Machining, EDM, laser, water jet, grinding inspection	ag
7	Plastics and Composites, Rapid Prototyping, EDM, laser, waterjet ECB & Electronic Manufacturing	ag
8	Introduction to measurement and error Limits and fits: Stack type functional requirements, fit type functional requirements	cm
9	Types and design of jigs and fixtures, dof, locating principles, clamping and holding mechanisms and actuators Joining and Assembly Processes	cm
10	Surface Engineering, Measurement of surface finish, concentricity	ag
11	Linear measurement methods and standards Angular measurement, squareness, tapers Practica/Lab: linear and angular measurement techniques	ag
12	Integration into CAD/CAM systems (SolidWorks and SolidCam)	ag
13	No Lectures	

Please note that the some of the topics may run over the indicated period if there are questions and the discussions are long.

8. RELEVANT RESOURCES FOR STUDENTS ENROLLED IN THE COURSE

Textbooks:

NONE PRESCRIBED
Download the PowerPoint notes or lecture notes and bring a copy to class.

Reference books:

1. Manufacturing Process Selection Handbook: From Design to Manufacture, Swift K.G., Booker J.D., 2013, Burlington, Elsevier Science, ISBN 9780080993607 – available from our library electronically
2. Applied Metrology for Manufacturing Engineering, Grous A, 2011, ISTE, John Wiley & Sons, Inc, ISBN 9781848211889
3. Low-cost Jigs, Fixtures & Gages, for limited production, Boyes W.E. ed., Society of Manufacturing Engineers, 1986, Dearborn, Michigan
4. Fundamentals of Modern Manufacturing, Groover M.P., 2nd ed., 2002 John Wiley

(all will be available to consult during the course).

9. COURSE EVALUATION AND DEVELOPMENT

The course has been completely redesigned in 2014 and will be evaluated at the end of this semester. Feedback on the course is gathered periodically using various means, including the Course and Teaching Evaluation and Improvement (CATEI) process, informal discussion in the final practica class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

10 USE OF CALCULATORS

You will need to provide your own calculator, of a make and model approved by UNSW. The list of approved calculators is shown at:
https://student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an Approved sticker for it from the School Office or the

Engineering Student Centre prior to the examination. Calculators not bearing an Approved sticker will not be allowed into the examination room.

11. ADMINISTRATIVE MATTERS

You are expected to have read and be familiar with Administrative Matters, available on the School website. This document contains important information on student responsibilities and support, including special consideration, assessment, health and safety, and student equity and diversity.

Erik van Voorthuysen
February 2015