

# The Process of Updating Production Engineering in an Australian Regional University Excellence in Developing e-learning

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**Abstract**—The aim of this paper is to share the processes in revitalizing the courseware of the course, *MEC3204 Production Engineering* coded as, in the Bachelor of Engineering (Mechanical), Bachelor of Engineering Technology (Mechanical) and Associate Degree in Engineering (Mechanical) programs offered by the University of Southern Queensland (USQ), a regional Australian University with excellence in developing e-learning [1]. The paper describes how the authors review the courseware of the course. The needs for the review are also explained. The lecture and tutorial schedule as well as the assessments of the course were also studied and revised. The authors also estimated the costs involved in reviewing the course. At the same time, the paper also predicts the benefits that will be offered to students and the community including employers who are going to employ USQ graduates. It is finally concluded that the review is worthwhile and the actual costs to the university are minimal.

**Index Terms**— advanced manufacturing, industrial engineering, metrology, production engineering

## I. INTRODUCTION

Production engineering is a combination of manufacturing technology with management science. Production engineering encompasses castings, joining processes, metal cutting & tool design, metrology, machine tools, machining systems, automation, jigs and fixtures, and die and mould design. In USQ, the coverage is not so wide, it consists of metrology, industrial engineering (some topics of management science) and advanced manufacturing and is offered as the core course to three degree programs, Bachelor of Engineering (Mechanical), Bachelor of Engineering Technology (Mechanical) and Associate Degree in Engineering (Mechanical). Some of the components of ‘*Production Engineering*’ have been covered by other courses, e.g. *MEC2002 Manufacturing Processes* and *ENG4004 Engineering Management Science*. It is a one-semester course and is only offered in semester two (2)

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every year. In addition, the course is also offered as face-to-face on-campus study as well as print based delivery, in which studybooks and other materials, e.g. CD-ROM are mailed to students worldwide. Additional supports given to off-campus students include communication by telephone, e-mails and StudyDesk through the Internet [2]. For the on-campus study, the course is currently available only at Toowoomba campus (other campuses are in Fraser Coast and Springfield).

## II. NEED FOR REVIEW

It is necessary to make a review on the topics and contents of the course because it had been offered in its present form for fifteen years. It is the time to see if some of the topics are to be changed, deleted or enriched. One enrichment necessary to the topics of the course is addition of software packages to solve the problems of some modules. If these were absent, people will think that the course is out of date as most production and industrial engineering textbooks included them in their topics. The methodology and tools used for the review include studying the contents of similar courses offered by engineering faculties of other universities. Several international textbooks have been acquired and read by the authors; many of them are interesting and challenging. One most worth mentioning book is *Automation, Production Systems, and Computer-Integrated Manufacturing*, which was published by Pearson/Prentice Hall in 2008 [3]. It will be prescribed as a textbook for S2, 2011 offer.

## III. STUDYBOOKS

In USQ, nearly all courses are delivered both on-campus and off-campus; USQ calls them hybrid mode; some courses are even delivered online. There are two studybooks this course have been written for both on-campus and off-campus students. The cost of the this study book together with an ‘Introductory Book’ containing two assignments and two sets of past examination papers for the course, is 70 Australian dollars; the off-campus students will receive them free from the USQ Distance and e-Learning Centre (DeC) via couriers but the on-campus students have to buy theirs from USQ bookshop. The current study book contains detailed information of each topic. It appears to the authors that students have substantial material to do well in the course. In addition, there are a lot of solved problems with detailed explanations on how they were solved. Students can easily learn the skills by attempting the self-assessment questions and past examination papers. In USQ, a course

team approach is used for the design and development of learning materials. The team consists of the course team leader, an instructional designer, and a materials development officer. Other specialist staffs in areas of multimedia, media, and graphics, publishing and copyright are utilized as required [4].

#### IV. EXISTING COURSEWARE OF MEC3204

The present courseware of *MEC3204 Production Engineering* consists of two parts and can be found in Figure 1. Part A comprises ‘industrial engineering’ and part B consists of ‘metrology’ and ‘advanced manufacturing’. They are three areas of industrial and systems engineering. The arrangement of the modules is given in Table 1 [5]. The first six modules form part A and is in a studybook. The other modules form part B and is in another studybook. Students are supposed to study parts A and B concurrently in the 13-week teaching period. Lectures and tutorials delivered to on-campus students are in the same format, i.e. parts A and B are studied concurrently. The student workload requirements are 84 hours which include lectures, tutorials, assessments and examinations. This is a full course and a student yearly load in Australia is 8 full courses. The textbook used is ‘Introduction to Work Study, ILO, 4<sup>th</sup> edition, 1992’ edited by Kanawaty, G [6]. The reference book is ‘Automation, Production Systems and Computer Integrated Manufacturing, 3<sup>rd</sup> edition, Prentice-Hall, 2008’ by Groover, M P [3]. The contents of all USQ engineering course are modified continually to meet the new accreditation requirements by Engineers Australia (the trade name of the Institution of Engineers, Australia) and the aspirations of our students and the demands of the job market. The first step to review the contents was to survey local industries via the Discipline Consultative Committee and our past students who have graduated in the last 3 to 10 years asking them whether the current contents meet their changing needs for the engineering workforce.

#### V. COURSEWARE OF OTHER UNIVERSITIES

The similar courses of five other universities Australia were studied. They were University of New South Wales, Royal Melbourne Institute of Technology University and University of Technology, Sydney, Australia. The characteristics of their courses similar to *MEC3204 Production Engineering* of University of Southern Queensland are tabled in Table 1 [7-9].

#### VI. NEW COURSEWARE

After carefully considering the feedback provided from all stakeholders, the author studied the contents of similar courses offered by other Australian universities, and drafted out a revitalized syllabus for the course, which was then discussed in the strand committee which eventually approved the new syllabus as depicted in Figure 2. From Table 2, it can be found that all similar courses in other universities mentioned were not totally equivalent to *MEC 3204 Production Engineering* of University of Southern Queensland, USQ. However, it can be found that the course(s) of University of New South Wales and University of Technology, Sydney are more similar to that of USQ *MEC 3204 Production Engineering*.

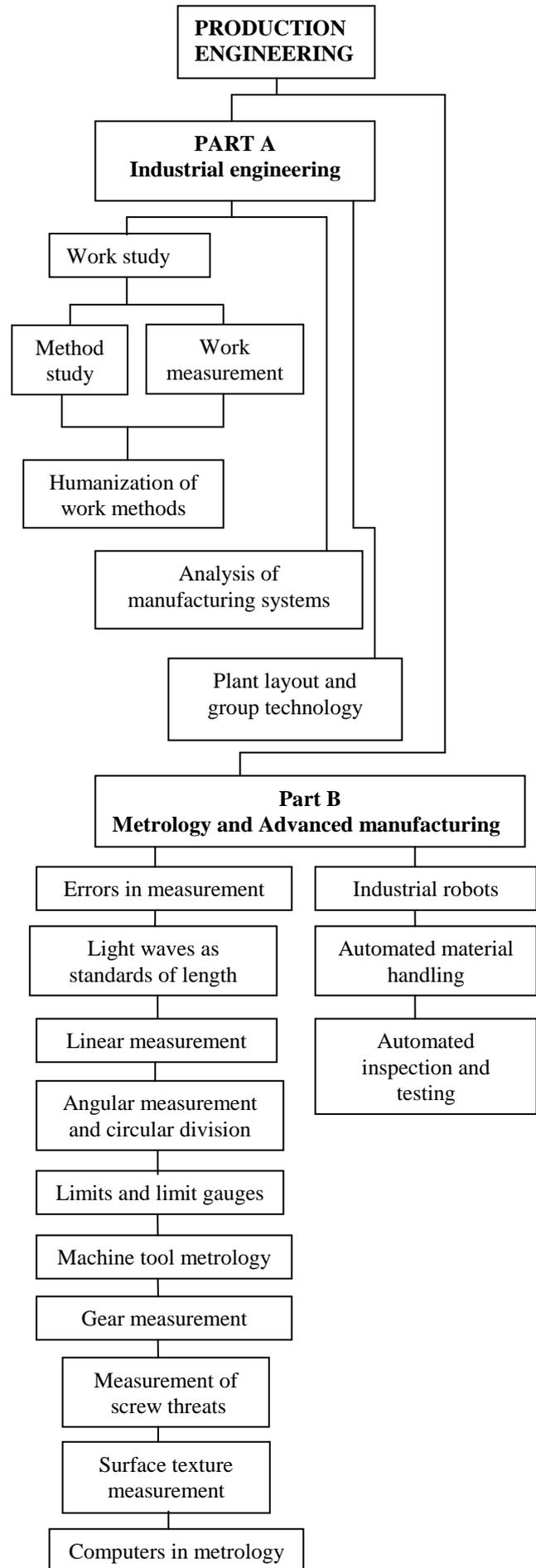


Fig. 1: Current courseware of MEC3204 Production Engineering

**Table 1: Arrangement of modules of existing MEC3204**

Module	Contents
1.	Work study
2.	Method study
3.	Work measurement
4.	Humanization of work methods
5.	Plant layout and group technology
6.	Analysis of manufacturing systems
7.	Errors in measurement
8.	Light waves as standards of length
9.	Linear Measurement
10.	Angular measurement and circular division
11.	Limits and limit gauges
12.	Machine tools metrology
13.	Gear measurement
14.	Measurement of screw threads
15.	Surface texture measurement
16.	Computers in metrology
17.	Industrial robots
18.	Automated material handling
19.	Automated inspection and testing

However, only 48663 *Advanced Manufacturing* of UTS contains ‘metrology’. Given the name, *MEC 3204 Production Engineering*, the course at USQ reflects its contents and it is comparable to similar courses offered by universities in Australia. On the other hand, *MANU2095 Manufacturing Systems* of RMITU also consists of ‘metrology’. The author believes that ‘metrology’ should be included in the re-vitalized syllabus of *MEC 3204 Production Engineering* because it is included in the courses of the two top universities in Australia. Furthermore, the local industries told the authors that it should be included as they still use some of its techniques, like gauges design. The author therefore decided to retain ‘metrology’ but reduced its weight from 30% to 15%, keeping only those contents useful to local industries. In the new syllabus, Part A consists of ‘metrology’, only which accounts for 15% of the course loading. Part B consists of ‘production systems’ which includes the whole Part A, ‘industrial engineering’ and ‘advanced manufacturing’ of the previous syllabus plus a new module, ‘automated production lines’ which is the continuation of the former ‘advanced manufacturing’. In the last three to four years, the module, ‘automated inspection and testing’ of the ‘advanced manufacturing’ had not been taught because the number of teaching week of a semester had been reduced from 15 to 13 weeks and there had been no time for it. Now, with the reduction in the contents of ‘metrology’ and the addition of a module, ‘automated production lines’, the whole course can be taught again in 13 weeks. Table 3 shows the arrangement of revitalized courseware of *MEC3204 Production Engineering*. With the new courseware, modifications to delivery will be made. Lectures and tutorials delivered to on-campus students will be so arranged that part A will be completed before part B starts. Part A will be completed in the first two weeks of a semester.

**Table 2: Courses similar to MEC3204 in other universities**

University	Course(s) similar to MEC3204	Contents
University of New South Wales, Australia	<i>MANF4100 Manufacturing Facilities Design 2</i>	analysis of manufacturing facilities, production and assembly lines, plant layout design, materials handling systems and warehousing, analytical approaches to line balancing, ergonomics in manufacturing
Royal Melbourne Institute of Technology University, Australia	<i>MANU2095 Manufacturing Systems</i>	Computer Aided Design and Computer Aided Manufacturing (CAD/CAM), Computer Numerical Control (CNC) and CNC programming, process planning, metrology, and advanced manufacturing technologies
University of Technology, Sydney, Australia	48663 Advanced Manufacturing	quality in manufacturing, metrology, machine vision, computer-aided manufacturing, computer-aided process programming, industrial robotics, flexible manufacturing systems, computer integrated manufacturing, production planning and control

University	Course(s) similar to MEC3204	Comments
University of New South Wales, Australia	<i>MANF4100 Manufacturing Facilities Design 2</i>	Covering most of part A (except ‘cost analysis’) and part B partially (part of ‘advanced manufacturing’) of MEC3204
Royal Melbourne Institute of Technology University, Australia	<i>MANU2095 Manufacturing Systems</i>	Covering most of part B (except ‘cost analysis’) of MEC3204
University of Technology, Sydney, Australia	48663 Advanced Manufacturing	Covering most of part B and partially part A (excluding ‘work study’, ‘inventory management’, ‘cost analysis’ and ‘line balancing’)

The new courseware will be developed in ICE (Interactive Courseware Environment) and will be in one studybook only, which will be delivered free to off-campus students for the last time in 2011. In the future, the courseware will be on the Studydesk only. Students will have to print it themselves if they wish to have a hard copy. It can be argued that by putting the courseware in Studydesk, USQ is shifting the printing cost to the students. However, students will receive an ‘Introductory Book’, which will advise students on how to study the course and will also contain assignments and two sets of past examination papers.

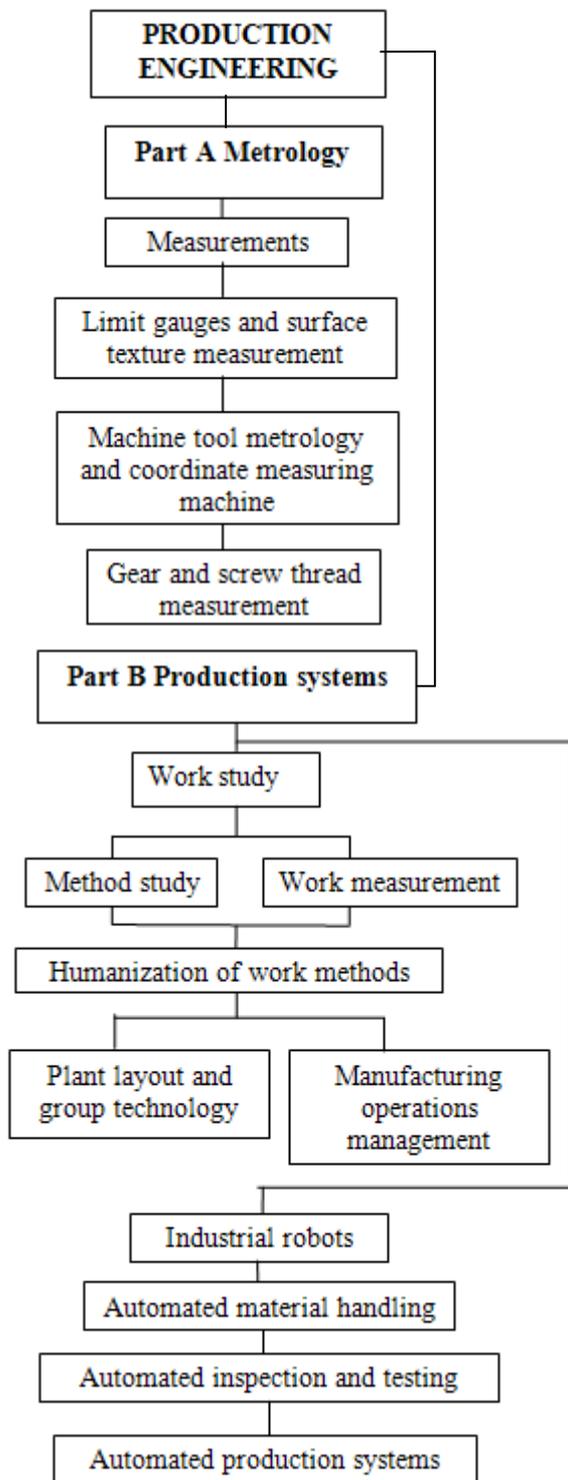


Fig. 2: Re-vitalized courseware of MEC3204 Production Engineering

## VI. I ENHANCEMENT OF CONTENTS

Another important thing for the review of the course is to enrich the material of the contents taught. The first thing required to be done is to add popular computer software to the contents taught so that students can solve some problems in the course faster and easier. In order to improve the skills of our students in solving the problems in the module of 'plant layout and group technology', spreadsheet, e.g. *Microsoft Office Excel 2007* will be used as a tool to solve problems in the module. There will be no extra cost to

students as this package has been installed in all USQ computers.

The author also recommends using spreadsheet to solve some of the problems in the topics of 'work measurement', 'cost analysis and 'inventory management'. Another software suggested for used is *Production & Operations Management – Quantitative Methods for Windows 3 (POM-QM for Window 3)*, which will be attached to the textbook of another course, *ENG4004 Project and Operations Management* studied by the students of BEng in mechanical engineering and BEng in electrical engineering. Students will no need to pay extra as they have to purchase the textbook for *ENG4004 Project and Operations Management* when they take it. *POM-QM for Window 3* will be used in solving the problems in all of the above 4 modules mentioned.

Table 3: Arrangement of modules of re-vitalized courseware of MEC3204 Production Engineering

Module	Contents
1.	Measurements
2.	Limit gauges and surface texture measurement
3.	Machine tool metrology and coordinate measuring machine
4.	Machine tool metrology and coordinate measuring machine
5.	Gear and screw thread measurement
6.	Work study
7.	Method study
8.	Work measurement
9.	Humanization of work methods
10.	Plant layout and group technology
11.	Manufacturing operations management
12.	Industrial robots
13.	Automated material handling
14.	Automated inspection and testing
	Automated production lines

## VI. II ASSESSMENTS

At the moment, S2, 2010, there were three assessments for the course, two assignments and one examination. The first assignment deals with 'method study' with a weight of 15%; the other was for 'metrology' has a weight of 15%. All assignments were marked by a part-time lecturer with a final check by the examiner. Suggested solutions with marking schemes were sent to students via StudyDesk on the due date of each assignment and no extension of assignments was permitted. External students handed in their assignments by mail via the USQ Distance and e-Learning Centre and were returned to them via the same pathway. Students are expected to spend five hours on assignment 1 and three hours on assignment 2. The last assessment is a 2-hour restricted examination which comprises of two sections. Section A contains 5 questions which come from part A of the syllabus and section B comprises of 5 questions which come from part B of the course. Students need to attempt 2 questions from each section. The weighting of the examination is 70%. In section A, there are five (5) 'industrial engineering' questions, excluding method study; in section B, there are three (3) 'metrology' questions and two (2) questions from 'advanced manufacturing'.

From 2011, S2 onwards, there will be some changes to the assignment due dates and, lecturing and tutoring schedule for the course. This time assignment 1 will be 'metrology' and its weighting is 10%. Assignment 2 will be 'method study' with a weighting of 20%. This is due to the reduction of 'metrology' weighting in the course. Suggested solutions with marking schemes were sent to students via StudyDesk on the due date of each assignment and no extension of assignments was permitted. External students handed in their assignments by mail via the USQ Distance and e-Learning Centre and were returned to them via the same pathway. Students are expected to spend 2 hours on assignment 1 and 6 hours on assignment 2. The last assessment is a 2-hour restricted examination which will comprise nine questions (9) which include five (5) 'industrial engineering' questions, excluding method study, one (1) 'metrology' question and three questions from 'industrial robot', 'automated material handling', 'automated inspection and testing' and 'automated production lines'.

From 2012, students will be able to submit their assignments via the Internet through EASE (Electronic Assignment Submission Environment) so that the assignments can be received by the staff at the deadline. In addition, marking will also be done electronically using Smart Touch computer via the help of PDF-viewer. As a result, students can get the feedback quickly and at the same time suggested solutions will be uploaded to the Studydesk so that students can read them as well. The whole process is to improve the service to students to increase USQ competitiveness in the deregulated higher education market in Australia, which will be effected in 2012.

## VII. DISCUSSIONS

It can be argued that USQ places more or less the same emphasis in production engineering in her mechanical engineer programs than similar programs in other universities in Australia. The syllabus of the current *MEC 3204 Production Engineering* pays more emphasis of 'metrology' than similar course(s) in other universities but pays less attention to engineering management science or operations management. USQ compensates the contents of engineering management science or operations management by offering *ENG4004 Project and Operations Management* in her programs. In addition, the reduction of 'metrology' contents, and the re-surrection of the module, 'automated inspection and testing' and the addition of the module, 'automated production lines' from the current modules, make *MEC 3204 Production Engineering* more in line with the syllabi of course(s) offer by other universities in Australia.

On top of it, the addition of the software packages to the modules in the course will certainly improve the academic standing of it because its contents are now at par with most of international textbooks. Students will also be able to apply what they have learnt from the course to their workplace with ease as they will not need to do complicated iterations or calculations. All can be done quickly done by software packages.

Furthermore, the inclusion of suggested solutions with marking scheme to the two sets of past examination papers in the '*Introductory Book*' will let students know what are

expected from the examiner and how the marks are allocated within each question. This will surely improve the performance of students

Up to now the total cost for revitalizing of this course, *MEC 3204 Production Engineering*, is Australian dollars \$ 3,315 by allocating 100 hours of the author's workload to part-timer for marking, which is in fact a small fraction of the annual income from the course. The course has an enrolment of 40 on-campus students and 50 off-campus students in semester 2. The fee each student (for domestic students, the government subsidy has been included) will pay to USQ will be Australian dollars \$ 2,750. The total income from the course per year is therefore =  $90 \times \$ 2,750 = \$ 247,500$ . In order to enable readers to compare the costs of reviewing this course with the living standard in their countries, it will be necessary for the authors to let them know that the average income of Australians in August 2010 was \$ 62,500 per annum.

## VIII. CONCLUSIONS

The revitalization of the course has been fruitful as it reveals the modules slashed or added enrich the syllabus so that it meets the need of industry, Engineers Australia as well as the aspiration of the students. It is worth mentioning that USQ Engineering programs have been reaccredited by the Engineers Australia for another 5 years. The new courseware will benefit the employers of our graduates, who are then better equipped with production engineering knowledge required by industries. The revitalization is worthwhile with little cost to the University.

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