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Computer Aided Engineering and Machine Drawing: a modern method

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ABSTRACT
The rapid change in teaching of engineering drawing using computer aided design (CAD) technology makes a tremendous change on the staff/students in teaching/understanding engineering drawing in technical institutions. Mastering CAD technology has become order of the day for staff/students especially in technical institutions. CAD course have become a compulsory subject in many technical university and institution. This paper is a research on the teaching of Computer Aided Engineering Drawing (CAED) and Computer Aided Machine Drawing (CAMD) courses. The problems are discussed on the present and future development of course content and teaching methods of these subjects. There are several solutions are evolved in designing the content, difficulty of the course and also improving the teaching methodology.

Keywords **- Computer Aided Design, Computer Aided Engineering Drawing, Computer Aided Machine Drawing, content, teaching methods**

1. INTRODUCTION
Objectives of drawing are (1) Accuracy: The drawings are not useful to the maximum extent if they are not accurate. (2) Speed "Conversion of Time into Money" in industry. There is no place for the slow technician, or engineer. Speed is not attained in a hurry; it should be with intelligent and continuous work. It comes with practice. (3) Legibility: Drawing is a means of communication to others, and that it should be clear and legible to serve its purpose. Care should be taken especially in dimensioning and lettering.
The introduction of the one of the best ways to communicate one's ideas is through some form of picture or drawing. This is especially true for the engineer. The purpose of course content is to give you the basics of engineering sketching and drawing. The Computer Aided Engineering Drawing and Computer Aided Machine Drawing is developing with a faster rate in many universities, computer have become an important tool in present day to draft, design and developmental process. Variety of CAD software's are available for drawing two dimensional (2D), three dimensional (3D) modeling and also for various views of an object to suit the CAED and CAMD courses as well as to meet the industrial standards. These CAD software and hardware can finish the task starting from 2D, 3D, smart dimensioning, converting 2D to 3D or 3D to 2D of front view, top view, side view, bottom view, rare view and isometric wire frame model with and without hidden edges of 3D objects, 3D rapid rendering, even physical properties of 3D objects or even section of 3D objects (solids). Every engineering students/engineering faculty/engineer has to create drawing as per their or others requirement in the society. The creation will start with an idea in a brain and drawing on a paper or computer aided engineering drawing using CAD software. Therefore CAED course is very important in the present day technology for all disciplines of engineering. Hence, it is proved that drawing is the language of engineers. The teaching of CAED and CAMD courses will get an excellent development and achieved many creative results. However, these are small problems in content and teaching methods for these courses. This paper will try to explore these problems and excel with better solutions. Also it is very important for technical university/institutions to recruit the teaching faculty for CAED and CAMD courses [1].

2. PRESENT AND FUTURE DEVELOPMENT OF CAED AND CAMD COURSES FOR TEACHING
In early 1950's the study of CAD has began but the technology developed in mid 1990's. at that time, the computers, software and hardware were very expensive and options for CAED and CAMD were very less with limited funds. The technical universities/institutions set up these courses only for few disciplines that to for higher semesters. After computers become popular and economical the technical universities/institutions started to provide these courses and improving them. CAD software also provided attention to education sector to improve the standard quality of 2D drawings and 3D modeling of machine parts which in turn can directly manufacture using rapid prototyping machine [2].

At present, mechanical and industrial production engineering department in many universities/institution has CAED and CAMD course to meet the need of training the student as per course. The CAED and CAMD courses are been allotted into two different year/semester CAED based on 2D drawings using CAD software and CAMD is based on 3D modeling, assembling and simulation using CAD software. In first year/semester for all discipline of engineering 2D is taught and in higher semester or second year 3D is taught. Presently Teaching method of CAED and CAMD uses, chalk & talk, physical wooden models, power point presentations, audio and video interleave, macro media flash and 3D studio max software are used as teaching aid for better understanding for students.

CAED courses have become compulsory course with professional training subject. For example, there are two compulsory courses CAED in I/II semester for all discipline of engineering and CAMD in III/IV semester for certain discipline of engineering. These subjects have made very good teaching results. The students studying these subjects

can easily understand, practice and complete a course with better knowledge, this knowledge can be used for designing a new product and create their vacancies to jobs for themselves.

To promote these courses, the technical universities/institutions started separate labs and dedicated software with trained teaching and supporting staff to increase the creditability of the courses. The other disciplines of engineering like, electrical, bio-technology, civil etc wherever 2D drawings and 3D modeling is required started using this method to increase its efficiency of the courses.

In future CAED and CAMD courses gain lot of importance because every customer needs his product to be designed and developed in a unique way and further it should be tracked with designing, analysis, developing and manufacturing and to be maintained through out the life of the product in a systematic and technical way, also customer wants to see his product in every stage of life of product and customer wants to suggest on improvement of the product.

3 CURRENT PROBLEMS IN CAED AND CAMD COURSE TEACHING

3.1 Course difficulty: The number of hours for CAED and CAMD curriculum mentioned is not sufficient. Teachers should be well prepared with teaching aids like power point presentation, flash movie, audio video interleave, etc., with time constraints. Students cannot complete the syllabus well within the time. The reason for this is initially student need basic as well as advanced knowledge of course. Secondly, teachers with CAED and CAMD experience in technical university and institution are very few. So it is difficult to increase the standard of the courses. Thirdly CAD software has also complex or sometimes no solution for some of the operation like knurling. Fourthly every year new versions of CAD software are released with new technology and new commands with different tool bars and menu bars and also in between the software patches will be released, these patches are updates of software which has to be downloaded and updated or sometimes macro's has to be written. With all these problems a course become slightly difficult compare to other courses.

3.2 Content: CAD is widely used in technical universities/institutions. In this paper it is starting from 2D drawing in the I/II semester, then to 3D modeling in III/IV semester and finally converting 3D to 2D. Setting CAED and CAMD content becomes a problem because of CAD software gives solution. Selection of CAD software required to teach, number of hours required, marks/grades allocation for each individual chapters in the course. Usually in all technical universities/institution the number of teaching hours will be same for all courses and also same number of marks/grades for all courses. Number of problems will arise here while setting the content of these CAED and CAMD course because of which more number of hours is added in course. Some technical universities/institutions misunderstand the present day requirement with respect to industry. Hence, the content should be clear with concepts and strong theoretical background and also fit the industrial standards. If it is not so, content will be failing to meet the requirements of industries. Some deemed universities/institutions are failing to keep pace with technological developments and also lack of knowledge in implementing these courses. Students also need lot of time to meet the needs and requirements of industries.

3.3 Scheme of evaluation and scheme of examination: For each chapter and for each problem sketching (free hand drawing) and also drafting on computer to get CAD solutions using software is made so that students can understand and practice in a better way. Credits/marks are sub-divided as per practical class and on number of problems solved in a time frame. Then 40% of weightage is given to sketching and 60% for computer solutions. Separate question paper is prepared by the universities/institutions for each students i.e., each individual student has to get different question paper. These setting of question paper individual is a tedious and evaluating them is also tedious unless it is online. Finally, manual evaluation is done for cross checking and quality of evaluation.

3.4 CAED and CAMD teaching methods: Traditional teaching methods uses chalk and talk which is not sufficient for a better under standing. Teachers can also use power point presentation, audio video interleave, flash movie etc for modern methods of teaching. Some colleges are using both the traditional methods and modern methods. Teaching methods also based on knowledge of teachers and facility available at the source. Initially the concepts, theoretical knowledge, procedure and solution to the problems are taught in a conventional class room and then these are experienced in practical at CAD laboratory. This theoretical and practical takes a lot of time, hence it cannot produce good learning effects.

4 SOLUTIONS

4.1 Dynamic Curriculum: Since every year new versions of CAD software are released with new technology and new commands with different tool bars and menu bars and also patches will be released and also other full featured software will continue to emerge. It is very easy to establish a dynamic curriculum. In a limited number of hours and credits, the most important technology can be selected and every year/semester new curriculum can be made. Further more with the help of tutorials the student can learn simple operations themselves and also online solutions creates collaborative learning in this way students can create a CAED and CAMD domain to accomplish a complete knowledge system. Initially proper software should be selected because in the present day world many CAD software are emerging. There are many software available which gives the same output. Software which have more options and functions used by many organizations will be the best choice. Secondly, the syllabus as per the semester without extending the more number of hours required to complete the syllabus. Thirdly update the content and credits regularly. Finally these CAED and CAMD course are to be used to finish later product design in future.

4.2 On line question paper and evaluation: To avoid malpractices universities/institutions can use online question paper through internet with timer so that once student start answering the question the timer will start and when completed and submitted the answers the timer stops. Here even it will be helpful to note what time is taken to solve the

problems by the students. Since every question of engineering drawing will have definite solutions with options and with the same solutions and optional solutions a custom made or web based software can be developed where in the super impose of solutions on students question solved problems wherein based on the differences or similarity the credits/marks can be allotted and finally the results are displayed on the web portals.

4.3 Enhancing the teaching methodology: Teachers will use chalk and talk method, power point presentation, audio video interleave, flash movie, etc simultaneously they can also use the same CAD software for teaching. Wherein teachers can create solids like cube, prisms, pyramids, cylinder, cone etc very easily with simple commands and can also show front view, top view, side view and other views necessary as per content. Different color can also be added for every surface to give clear picture of an object. Not only views even these solids can cut at different angles and show the full sectional views, half sectional views, broken view, etc., for example cone can easily be sectioned at different angles where one can teach complete conic section (circle, ellipse, parabola and hyperbola). CAD software acts as an excellent tool for teaching in classroom and also in practical laboratory. Another example in assembly of screw jack modeling of all parts and assembling in CAD software virtually and further in assembly some parts can be made ground and some parts moving to give motion. The simulation is done to see working of the screw jack, exploded view of screw jack is analyzed and physical properties of screw jack are obtained. Even load to screw jack is applied for analysis, results are verified. Finally, the file is saved in audio video interleave with voice and these files will be an excellent teaching aids.

4.4 Preparing the students to establish an excellent learning concept: Students to establish good learning concept, step 1. the concept should be understood. Step 2 student should understand the difference between engineering drawing and computer aided engineering drawing wherein the concept remains same, only the tools are changed i.e, instead of using the mini-drafter, pencil and various types of pencils, eraser and other accessories student will be using CAD software. Step 3 the student should know the importance between sketch capacity and skills using the CAD software. Step 4 There should be through interaction between the students and the faculty, one of the problem found that student often completely depend upon computer to solve the problem. Students spend maximum time in learning and understanding the software, here faculty should pay attention to clarify that the software is a merely tool for computer aided engineering drawing. In addition, students should know CAED and CAMD is not only for 2D drawings and 3D modeling , student should understand about the complete development process under the aspect of computer aided engineering. That is conceiving an idea in a brain, concept and visualization about any new product to be development should be new learning concept. A case study is taught with case method and also real time problems can be taken and solved for better understanding so that students think independently instead of always following textbook step by step.

5. CONCLUSION

Computer Aided Engineering Drawing and Computer Aided Machine Drawing is a course communicates a precise description of a part with all details and better visualizations. Students improve in efficiency of designing the machine parts. The solutions provided in this paper are guiding teaching community with improved teaching methods and strengthening with proper resources. Hoping a good learning concepts are created for students. CAED and CAMD courses will be starting point for product life cycle management in academia and industry and also students will be industry ready for production.

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TABLE

Comparison between Engineering Drawing and Computer Aided Engineering Drawing

Particulars	Engineering Drawing	Computer Aided Engineering Drawing
Tools	Drawing board, Mini-drafter, Pencil, Eraser, Compass, Dividers, Set Squares, etc,.	Computer & CAD software
Point & Line Thickness	Depends upon types of pencil	Can be fixed (ex: projection line thickness as 0.05mm)
Storing Space	Drawing sheets needs lot of space	Since drawing are in digital form and smaller files than bitmapped images needs very less space
Preservation	Possible but difficult	Very easy because of digital file
Transfer	Possible but difficult	Very easy through out the Globe via internet
Precise	Depends upon the skill of individual	Very less skill is required because of software
3D detailed drawing	It has to be drawn	Can be acquired by a single command
Scalability	It has to be drawn	Can be acquired by a single command
Efficient	Less efficient because use of many tools	Since software is very efficient
Conversion from 3D to 2D	Not possible	Possible
Animation	Not possible	Possible
Editing	Not Possible	Possible and even online via internet
Analysis & Testing without actual produce	Not Possible	Possible using analysis software
Virtual Manufacturing	Not Possible	Possible using software
Prototyping	Not Possible	Possible using Prototyping machines