

# A Sophomore Proto-Simulation Course

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## **Abstract**

*The fast growing advances in the development and use of computational tools in different engineering fields requires engineers who are well versed in the use of these tools. To address this need we have designed a course called “Engineering Technical and Graphical Communication” to familiarize students with several major simulation packages. In this course students learn the fundamentals of these software programs in their third semester at Manhattan College and then make use of them at all levels of the mechanical engineering curriculum. In their last two semesters they are able to utilize multiple computational packages required for the “senior design project”. This systematic exposure to different software tools helps students to prepare themselves for a profession that demands a complex mix of different simulation and modeling packages.*

## **Introduction**

Engineers have always used different techniques to create and communicate their design ideas, and as time as gone by representations have evolved from maps on stone to 3D Computer Aided Design and Drafting (Barr and Juricic, 1994). Unfortunately traditional educational methods may not provide students with the skills and tools that the workplace demands (Mailhot 2008). In an effort to tackle this concern many mechanical engineering schools introduce simulation software as it is needed in appropriate courses. This approach however requires time to be taken out of the class schedule to teach the students the basics of the program in question. This could also be done by requiring the students to become familiar with the program outside of class, however, this often results in a poor understanding of all the features associated with the software and in some cases a complete misunderstanding of the mathematical principles employed by the program. In the mechanical engineering department at Manhattan College this issue is addressed by introducing the students to the department’s major simulation packages (word, excel, Mathcad, Revit, and NX) in a required first semester sophomore class. In the following section the details of the course and its advantageous are explained.

## **Course description**

The class has four contact hours split into two, two hour sessions. This allows the salient features of the software to be presented in the first hour, followed by a “Simon-says” hour where the students follow the instructor as he or she uses the primary elements of the software to tackle problems that the package is specifically designed to address. In second two hour session the students are given their own set of tasks that they have to address using the features of the software that they had learned in the previous two hours. A small quiz is then given the following week to gauge how well the students understood the material.

### **Packages Covered**

Word is not a simulation package, however since it is used ubiquitously throughout the Mechanical Engineering Program in laboratories and design classes, it was felt that all students should be familiar with the more advanced features of the software, such as how to construct tables correctly, how to use the drawing features, and how to create well formatted equations using the equation editor. This part of the course is covered within the first week of the class and is associated with a departmental writing style manual that all students are expected to follow when submitting written material associated with any mechanical engineering class.

Excel may not be regarded as a “true” simulation package either; however, it is so common throughout the engineering profession that it is necessary that all students be conversant with such features as Goal Seek, Solver, and the Data Analysis Add-In. In addition, the students are given a rigorous grounding in all aspects of graph creation and formatting to allow them to produce professional quality charts in all subsequent classes. Again, as with word, only one week is devoted to this software package.

Mathcad is the next package introduced to the students and is a package that is used widely throughout the department for use in homework, design projects, and laboratory assignments. The main features of the program are covered in this class such as the basic equation solver, graphical presentation, statistical analysis, vector and matrix calculations, numeric differentiation and integration, and elementary symbolic manipulation. This takes five weeks of the course and at the end of this section the students also have a collection of Mathcad files that are directly usable in subsequent classes, such as statics, solid mechanics, fluid mechanics, thermodynamics, and heat transfer.

Revit is the first major simulation package to which the students are exposed. AutoCAD, the two dimensional companion to Revit, is used in a freshman general engineering class to provide all engineering students with the ability to produce basic two dimensional renderings of engineering components. Revit however, being a three dimensional simulation software tool, permits students to construct full three dimensional buildings, which can be used in conjunction with HVAC tools to analyze the heat load and thermal behavior of buildings, thereby giving the

students a more realistic appreciation of heat transfer concepts in the required thermal/fluid system design class and in the elective HVAC class in their senior year.

The primary computer-aided engineering package used by the department is NX, however to ensure that the full power of this package is employed correctly a good solid model has to exist; therefore a significant amount of time is spent on different solid modeling, assembly, and drafting aspects of NX such as extrude, loft, and feature creation. Time is also taken to engender good solid modeling practices and thereby facilitate the creation of parts that are easy to export to other software packages such as Abaqus and Inventor, and are easy to use in the subsequent required junior finite element class and junior manufacturing laboratory where the computer-aided manufacturing component of NX is used to generate g-codes for a four-axis mill. The good solid modeling practices learned in this class also allow full natural frequency and modal analysis projects to be undertaken in the senior vibration class. Finally, the drafting component is introduced to the students as a tool that can be used in their senior design class where correct part drawings of assemblies are required.

### Results

A questionnaire was given to the present (Fall 2013) senior class of mechanical engineering students to gauge the degree to which they believe the material covered in this course was of use to them during their second semester sophomore and junior years. The question asked was “When it was suitable to use *Software Package X*, to what degree did you use it effectively in courses after MECH 211?” with the options being from Not at all (1) to Very often (5). The results (Table 1) showed that the students found Excel and Mathcad to be of significant use, while both NX-Ideas and AutoCAD were deemed to be of little use (based on a Chi-Square test these results had a level of significance of at least 10%).

	Degree of Use				
	1	2	3	4	5
Excel	0	0	2	10	22
Mathcad	2	5	8	13	6
AutoCAD	11	11	2	2	4
NX-Ideas	11	7	8	2	1

Table 1: Results of the student software package usage questionnaire

The disparity between the results associated with excel/Mathcad, and AutoCAD/NX can be explained by the fact that excel and Mathcad have been a part of the course since its inception, however, AutoCAD and NX-Ideas was replaced with Revit and NX8 in the Fall of 2012 to accommodate changes in industry. Consequently, the present senior class which was taught how to

use AutoCAD and NX-Ideas have not had the opportunity to experience a continuous use of the two drafting packages that they were taught. However, this survey will provide a baseline with which to measure the future effectiveness of this pedagogical approach.

### **Conclusions**

To fully prepare students to enter the engineering profession, we have introduced a new course called “Engineering Technical and Graphical Communication” which is a required first semester sophomore course. In this course we introduce major simulation packages (word, excel, Mathcad, Revit, and NX) to the students. By presenting simulation software in this way several advantages have been observed: 1) time is not wasted in later classes to teach them the software; 2) by introducing the packages to the students at such an early stage in their academic career they have the opportunity to use the programs in many subsequent classes thereby improving their familiarity with the software and allowing them to learn new features easily; and 3) by the time the students then become seniors their multiple exposures to these various packages allows them to use the software productively in their two semester long senior design class.

### **References**

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Mailhot P. (2008). *Rethinking Engineering Education*. Journal of Engineering Education, Vol. 97, Issue 3. Page 243