CHOOSING THE RIGHT PARAMETRIC MODELING SOFTWARE FOR YOUR ET PROGRAM

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Abstract

Keeping up with technology has always been a challenge, and parametric modeling software is a prime example. This paper presents findings from a project that deals primarily with answering a few key questions that every Engineering Technology program should ask when incorporating 3D graphics software into its program: What software is being used in industry? Which software packages should we use? Is it beneficial for students to be familiar with more than one type of software? How important are software certifications? A survey was created in order to help answer these questions. The survey was then sent out to several Engineering Technology program constituents. The constituents are made up of Advisory Board members and various industries that have hired Mechanical, Manufacturing, Plastics, and Electronics students in the past. Results from the survey were assessed and then decisions were made about how to implement the software into the ET program curriculum.

Keeping Up With Technology

For years two-dimensional drafting has been the standard for creating drawings. These drawings were used to convey ideas to customers or to give machinists something to create an actual part. Drafting on a table with mechanical pencils, T-squares, and triangles was the preferred way to create drawings. But as with everything else in today’s society, technology is driving change in the world of engineering graphics. The days of learning to draft on a board are quickly giving way to three-dimensional, parametric modeling as the preferred method of conveying geometry and dimensions of a part.

The PSU MET Program content was based on the historical program development versus meeting defined and documented constituent driven objectives. The program evolved from a drafting, then machine design/drafting program to an ABET/TAC accredited engineering technology program. The ‘baseline’ program courses and course content matched the faculty credentials (2 faculty, 50%, engineering, 2 faculty, 50%, drafting) in 2000 when objectives were written to support constituent need as required by new accreditation criteria.

The program baseline graphics communication courses and content included Engineering Graphics 1, Engineering Graphics 2, Computer Aided Drafting and Advanced Engineering Graphics. The first 2 courses were manual drafting courses with the content focus on producing drawings with a pencil and paper. Topics included, visualizing and drawing a 3-D object in a 2-D view, lettering, using manual drafting instruments, creating 2-D geometry (lines, angles, arcs), placing dimensions and tolerances, converting 3-D objects into 2-D descriptions to produce a 3-D shape. The 3rd and 4th course applied the content of the first 2 courses to learning to use a 2-D computer aided drafting tool, AutoCAD, to create 2-D geometry and drawings. The program baseline included an optional 5th course that introduced students to a 3-D software tool, AutoCAD – Mechanical Desktop.
A major strength of the baseline content was the emphasis on content that matched the educational and work background of the program faculty with drafting credentials. A second strength was the use of AutoCAD software, a well-recognized software, used widely in industry, and with an extensive amount of teaching resources.

Weaknesses of the baseline were; the software did not efficiently support follow-on course content and activities (structural analysis, computer aided manufacturing); industry was rapidly adopting 3-D, parametric modeling software; there were 3 other software packages being used in industry, CATIA, Pro/Engineer and Solid Works.

Like any other technology trend, there are several software packages to consider when deciding what is best for your curriculum. This brings up many questions when trying to decide what is best for your Engineering Technology program: Who are the constituents? What software is being used in industry? Is it important for students to graduate with knowledge of more than one type of software? Are software certifications important? This is the scenario we were recently faced with in the Engineering Technology program at Pittsburg State University. This is the process we went through to help answer these questions, and ultimately choose the software packages we use today.

Software in Industry

There are a wide range of software programs being used in industry today. Some are used on a large-scale while others may be more proprietary and therefore used on a smaller scale. The more popular versions of parametric modeling software were developed to be used in specific industries. The software that we reviewed is listed below:

Pro Engineer was originally released in 1987 and was recognized as the first successful parametric modeling software. It is primarily used in product development and consumer products. It is quickly spreading into the aerospace and automotive industries. (http://www.ptc.com)

Solid Works was introduced in 1995 as a low-cost competitor to the other parametric modeling software products. It was purchased in 1997 by Dassault Systemes. It is primarily used in mechanical design applications and has a strong following in the plastics industry. (http://www.solidworks.com)

Catia was created in the late 1970’s by Dassault Systemes in France. I was developed for the sole purpose of designing the Mirage fighter jet, and is still widely used in the aeronautic, automotive, and shipbuilding industries. (http://www.3ds.com/products/catia)

Inventor was released in 1999 to compete in the 3D market. As with other Autodesk products Inventor has been embedded in Technical Education. Inventor is gaining popularity in plastic part design due to the recent purchase of Mold Flow analysis. (http://usa.autodesk.com)

NX, previously known as Unigraphics, was purchased by McDonnell Douglas in 1977. Unigraphics originated in the aircraft industry and is currently lagging behind in market share. (http://www.plm.automation.siemens.com/en_us/products/nx)
Creating a Procedure

How do you determine which software is appropriate to use in your curriculum? This is the procedure we created at PSU to determine which software packages we were going to use:

- Review program majors and determine which software is used in that field.
- Research job placement trends for graduates.
- Define constituents.
- Send out surveys. This can include advisory board members, alumni, and prospective companies.
- Budget allowance for software may also be a factor. Some institutions are unable to procure the software they want or need. If this is the case, keep in mind that there are several companies that will give special “institution pricing” to help lower costs.

Program Majors and Job Placement

As stated in an earlier, certain industries have historically gravitated toward particular software packages. The ETECH program at PSU contains majors in Electronics, Manufacturing, Mechanical and Plastics Engineering Technology. Each major represents an industry that uses different software. To ensure that students learn to use the software that is prevalent in their industry, we provide four different software packages (Pro/E, Solid Works, Inventor and Catia).

Job placement data is another point of interest to be considered while making decisions. Working closely with your institution’s Career Services department can help you determine which industries are hiring your graduates. Other sources to consider are job search websites such as Monster.com and Careerbuilder.com. Type in each of the software packages we have been discussing and tally the job search results. This is a very timely representation of what companies are looking for right now (See Figure 1).
Defining Constituents

Constituents are users of the product or service. Constituents have a “need” for the product or service. Constituents must play a leading role in defining and establishing the objectives and outcomes of a program. The objectives and outcomes should state what performance is needed and include a quantifiable benchmark for evaluating the performance, “performance measure”. Meeting or exceeding the benchmark is the aim of the process; performance below the benchmark should result in changes to the program leading to improved performance.

Assessment is a critical part of the continuous improvement process and the program constituents must play a significant role in assessment. The constituents must be aware of the program content and a mechanism must be in place for them to evaluate performance.

The Pittsburg State University (PSU) Engineering Technology program is made up of four separate majors: Mechanical Engineering Technology (MET), Plastics Engineering Technology (PET), Electrical Engineering Technology (EET), and Manufacturing Engineering Technology (MFGET). For example the Pittsburg MET Program primary constituents are the University/State, Industry, and Alumni/Students. PSU and the State of Kansas are constituents because they have decided for the good of the state a MET program will exist at PSU; graduates of the program will get jobs in the state, improving the quality of life for residents and generating state revenue by paying taxes. Industry is a constituent because they hire the program graduates for the graduates knowledge and skills that are used by industry to produce a variety of goods and services. Alumni and students are constituents because they directly use the knowledge, information and skill available through the program and pay for the services provided.

Secondary program constituents are the program faculty and other programs within the University that support their program with the MET program content. Other programs are secondary constituents because, even though they use the MET content, if they did not, the MET program would still exist and be required to meet the needs of the primary program constituents. Although the program faculty are experts in their field, they are not primary constituents … they are not users of the service, they are providers of the service. Program faculty must be included as constituents and in the continuous improvement process because they are in direct contact with the product during its creation and they know the resources of the program. Faculty, typically, want to play a very active role in defining the program, however, ‘faculty inside the program should not define the program’. The program faculty role must be ensuring the program objective and outcomes can be met with the resources of the program and as a source of data to support the continuous improvement process.

Constituent Observations

The PSU MET Program objectives and outcomes were documented in 2000 as a part of the program adjusting to new ABET accreditation criteria which emphasize meeting the needs of program constituents. Program changes/improvements should be made when the constituents observe the program activities do not lead to meeting the performance standards of the objectives/outcomes.

Objective 1 was being met. The MET program regularly placed 100% of the program graduates in mechanical or manufacturing job. The graduates were receiving competitive salaries and were
earning promotions at a rate that indicated the program graduates were desired by industry and on the job performance benefited the company for which they worked. Objective 2 was the cause for concern. Program assessment led to the observations that the student skills were weak and that the program was not exposing students to emerging technologies and important modern tools of the discipline. These observations came from the program industry advisory committee, students, and program faculty.

The MET industry advisory committee, the primary tool used to get industry constituent input, participated in the assessment of the program by reviewing ‘capstone’ project presentations. Drawings presented were unclear and incomplete; members of the committee identified the baseline program content weakness stating other, newer software is being widely used in industry. Many committee members felt students should learn and use the 3-D software tools first and then learn the 2-D tools.

Students through end-of-program questioning stated that too much time is being spent in courses on manual drafting which is not being used by industry; the program needs to introduce and use 3-D software earlier in the program.

Program faculty added the observation that upper division course content coverage was being limited because instructors were forced to teach students how to operate 3-D graphics tools instead of teaching how to apply those tools to solve problems on the course subject. Some of the program faculty shared the feeling that capstone students showed weak graphics communication skills.

Other ETECH programs, Electronics, Manufacturing, and Plastics were adamant in observing that the baseline content was not meeting their industry constituent needs and 3-D software must be covered in the first 2 graphics courses.

Creating a Survey

An online survey (See Appendix 1) was developed to help verify the types of software being used in industry, as well company’s opinions of which software skills new graduates should possess. One of the questions on the survey asks “What design software does your company use?”, and if they use more than one they are asked to mark all that apply (see Figure 2). The overwhelming response to this question at 74% was 2D AutoCAD. This may be due to the fact that AutoCAD was one of the first and most widely used software packages and the software has become embedded into the company. Companies are likely to hang on to this software since the majority of their drawings are already in AutoCAD, or their designers are already proficient with the program. With that being said, the trend is moving toward 3D parametric modeling software. Therefore, these are the types of programs our institution is leaning toward, and that is what we are focusing on in this survey.
Other Considerations

The Pittsburg State University ET program currently provides four of the five software packages as mentioned earlier. We will be choosing one software package as our primary teaching tool throughout the ETECH program; however it is our belief that exposing students to the different software will give them an advantage when they are searching for jobs. A resume that lists knowledge of four different 3D software packages clearly has its advantages.

Software Certification is another hot topic right now. Companies are looking for employees that hold these certifications. Solid Works, Inventor, and Catia all have some type of certification exam. Pro Engineer only has a certification for those who wish to be Pro/E instructors. Certification exams are a good way to perform an assessment of your ET program. This can also be used as an ABET assessment tool.

Conclusion

After setting up this process and analyzing the results of our online survey, we have made the following decisions for our ET program at PSU.

Use Solid Works as the primary teaching tool in our Engineering Graphics curriculum. It appears to be widely used in several areas of industry, and has been quickly gaining market share. It is user-friendly software with great tutorials and also has an excellent analysis tool. Solid Works also offers a series of certification exams that can be integrated into our curriculum and used as an assessment tool for our ABET accreditation.

We will also continue to provide Pro/E, Catia, and Inventor as secondary teaching tools. We still believe that having knowledge of these software packages is a true benefit to the students.
Appendix 1. Online Survey (http://surveymonkey.com)

Engineering Graphics Survey

1. Introduction

It is a well-known fact that technology is constantly changing. As an educational institution, the Engineering Technology department of Pittsburg State University prides itself on staying current with the tools used in industry. This survey has been created in an attempt to determine which Engineering Graphic skills are desired in today's workplace.

1. Please complete the following information. (Optional)

Please complete the following information. (Optional)

Name

Company

Department

2. What is your core business?

- What is your core business? Automotive Industry
- Appliance Industry
- Medical Industry
- Aerospace
- Motion Control
- Packaging
- Electronics
- Plastics Manufacturing
- Manufacturing Automation Technology
- Other (please specify)

3. Does your company use 3D parametric modeling software?

- Does your company use 3D parametric modeling software? Yes
- No

*  

4. In what capacity does your company use 3D parametric modeling software? (Mark all that apply)
☐ In what capacity does your company use 3D parametric modeling software? (Mark all that apply)
  ☐ Product Design
  ☐ Part Design
  ☐ Machine Design
  ☐ Fixture Design
  ☐ Creating 2D Working Drawings
  ☐ Creating 2D Assembly Drawings
  ☐ Do not use

5. Does your company use 2D drafting software?

☐ Does your company use 2D drafting software? Yes
☐ No

6. In what capacity does your company use 2D drafting software?

☐ In what capacity does your company use 2D drafting software? Product Design
  ☐ Part Design
  ☐ Machine Design
  ☐ Fixture Design
  ☐ Creating 2D Working Drawings
  ☐ Creating Assembly Drawings
  ☐ Do not use

7. What design software does your company use? (mark all that apply)

☐ What design software does your company use? (mark all that apply) Pro Engineer
  ☐ 2D AutoCAD
  ☐ Autodesk Inventor
  ☐ Solid Works
  ☐ Catia
  ☐ Unigraphics
  ☐ Other (please specify)

8. How important is it for your new hires to be familiar with the latest version of software?

☐ How important is it for your new hires to be familiar with the latest version of software? Very Important
9. What software skills do you believe new hires should possess and rate the importance of each.

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Other Engineering Software (please specify)

10. Do you feel it would be beneficial for new hires to possess certification in: (mark all that apply)

☐ Do you feel it would be beneficial for new hires to possess certification in: (mark all that apply)  Pro Engineer
☐ Solid Works
☐ Catia
☐ Autodesk Inventor
☐ Geometric Dimensioning & Tolerancing (GD&T)
☐ Certifications are not necessary

Other (please specify)

11. Of the following skills, which would you prefer new hires to possess? (mark all that apply)

☐ Of the following skills, which would you prefer new hires to possess? (mark all that apply)  Creating 3D models
☐ Creating 2D drawings
☐ Freehand sketching
☐ Finite Element Analysis (FEA)
☐ Creating assembly drawings
☐ Creating working drawings
☐ Proper use of GD&T

Additional Comments (please specify)

12. Have you witnessed an increase in the demand for new hires to be more knowledgeable in 3D parametric modeling?

☐ Have you witnessed an increase in the demand for new hires to be more knowledgeable in 3D parametric modeling?  Yes
☐ No

Additional Comments (please specify)

13. Do you feel it is advantageous for new hires to be knowledgeable in multiple 3D modeling software packages?

☐ Do you feel it is advantageous for new hires to be knowledgeable in multiple 3D modeling software packages?  Yes
14. Do you feel it is important for new hires to be skilled in freehand sketching?

☐ Yes
☐ No

Additional Comments (please specify)

15. Does your company employ GD&T practices?

☐ Yes
☐ No

Additional Comments (please specify)

16. What other topics do you feel should be covered in our Engineering Graphics courses?

What other topics do you feel should be covered in our Engineering Graphics courses?
**Greg Murray**
Greg Murray is an Assistant Professor in the Mechanical Engineering Technology Department of Pittsburg State University in Pittsburg, KS. He received his BSET in 1993, and his MST in 1995 from Pittsburg State University, and his MBA in 2002 from Wake Forest University. Professor Murray worked in industry for over 11 years in various product development, process engineering and management roles. He currently teaches subjects based in Engineering Graphics, Computer-Aided Design, Capstone, and Fluid Mechanics.

**Tim Thomas**
Tim Thomas is currently a professor and chair in the Engineering Technology Department of Pittsburg State University. He holds degrees from Kansas State University and Oklahoma State University in Mechanical Engineering. He has been a user and teacher of computer aided design tools for 30 years. Tim was one of the first to release product drawings and specifications with 2-D tools as a systems engineer in the aircraft industry. He introduced the use of finite element analysis tools in the curriculum at Pittsburg State University. Professor Thomas led the effort to use 3-D parametric modeling tools in the Pittsburg State’s Mechanical Engineering Technology Program. He continues to look for computer aided design applications in industry and methods to incorporate the tools in the classroom.