Using the Internet to Facilitate Manufacturing Technology Education

John C. Anderson, PE

Mechanical Engineering Technology Dept., Purdue University,
1417 Knoy Hall, W. Lafayette, IN 47909-6219
Ph. (765) 494-7526 email: jcanderson@tech.purdue.edu

Abstract - The primary distinction between Technology and Engineering education is the emphasis on applications in the Technology curricula. This emphasis usually results in much shorter learning curve for Technologists entering the work force in manufacturing industries.

The learning curve for a new technologist is largely driven by the ability to find information and to apply theory to actual applications.

This paper illustrates some uses of the Internet to bring current manufacturing technology problems to life in the classroom and also provide real world data gathering skills for the student. Classes in plastics manufacturing technology and in automation are used as examples.

Applications are presented using actual manufacturer's literature to design industrial control systems and polymer manufacturing systems.

This approach accomplishes several goals.

- It teaches students how to locate data on actual equipment.
- It facilitates an understanding of the theoretical principles taught in the classroom by applying it to problems involving commercially available materials.
- It facilitates projects that are closer to actual engineering assignments in industry.

I Introduction

One of the classic problems in engineering and technology education has been how to break the students dependency on textbook solutions and introduce them to finding information and fitting it to the solution of actual problems. Until recently this was left to a single "design course" experience. With ABET's emphasis on a "Capstone" experience for the students to synthesize their analytical skills with real problems there has been increased attention on the problem of teaching students how to find information.

The examples in this paper were designed to introduce information gathering skills at 200 level (Sophomore) courses. With some creative adaptation, similar problems could be designed for a wide range of courses.

Example 1 - Polymer Resin Properties

In a sophomore level survey course in polymers and manufacturing methods one of the goals was to get students to compare properties of common commodity plastic resins and to draw some conclusions from that comparison. The matrix shown in Fig.1 was designed as a homework assignment.

Figure 1 - Student Assignment Sheet, Properties of Commodity Plastics

Student Name	LLDPE	LDPE	HDPE	PP	Rigid PVC	Vinyl	PS	HIPS	SAN	ABS
Tensile Strength (psi)										
Impact Strength (ft lb/in)										
Solvent Resistance (1 to 10)										
Thermal Expansion										
Melt Index										
Mol wt.										
Relative Density										
Melt Temp., deg. F										
Glass Trans Temp., deg. F										
HDT , deg F										
Crystalline ?										
Permeability to Oxygen										
Cost, $/lb										

This information was available in several places in print, such as the Modern Plastics World Encyclopedia[1] and Plastics Technology [2]magazine. This information pertained to mechanical, thermal, and chemical properties of the polymers and to current market conditions (pricing). The pricing information was later used to raise awareness of cost distribution in plastics products.

All of the information was also available on the web at various web sites, and was probably easier to get on the web than in print media.

One of the best locations for properties was the "Campus Web View"[4] web site. The Campus web site consists of a common database with polymer performance data supplied by individual polymer manufacturers. A search screen and a portion of the information screen for a specific polymer are shown below in Figures 2 & 3.

Figure 2 - Campus Web View Search Screen

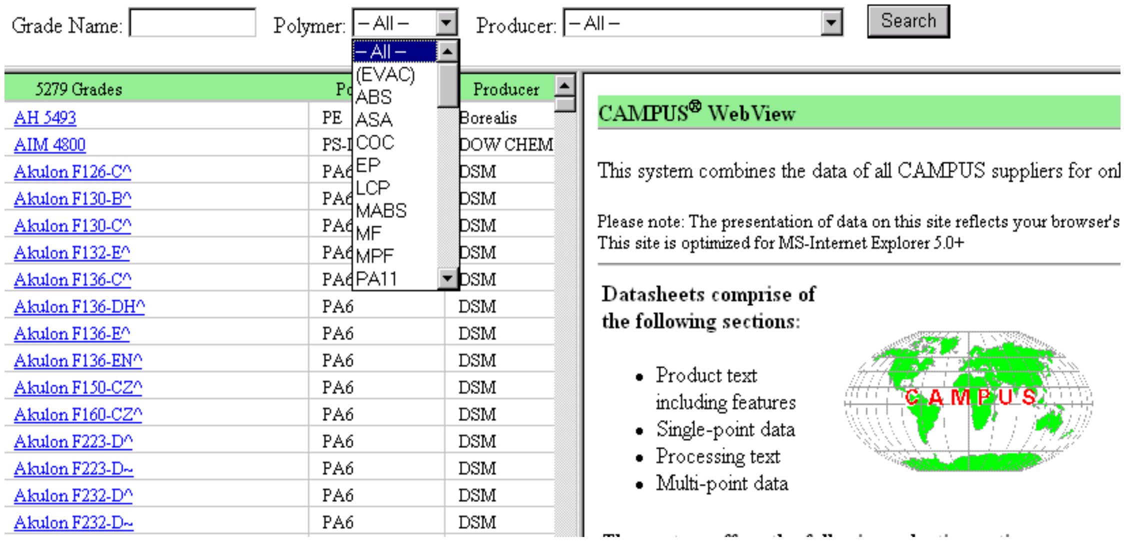


Figure 3 - Part of Campus Web View Information Screen for Specific Polymer

Mechanical properties [AIM 4800]			
Tensile modulus	1800	MPa	ISO 527-1 and -2
Yield stress	28	MPa	ISO 527-1 and -2
Yield strain	1.9	%	ISO 527-1 and -2
Nominal strain at break	40	%	ISO 527-1 and -2
Stress at 50% strain	-	MPa	ISO 527-1 and -2
Stress at break	*	MPa	ISO 527-1 and -2
Strain at break	*	%	ISO 527-1 and -2
Tensile creep modulus (1h)	-	MPa	ISO 899-1
Tensile creep modulus (1000h)	-	MPa	ISO 899-1
Charpy impact strength (+23°C)	105	kJ/m²	ISO 179/1eU
Charpy impact strength (-30°C)	92.7	kJ/m²	ISO 179/1eU
Charpy notched impact strength (+23°C)	25	kJ/m²	ISO 179/1eA
Charpy notched impact strength (-30°C)	2	kJ/m²	ISO 179/1eA
Tensile notched impact strength (+23°C)	-	kJ/m²	ISO 8256/1
Puncture - maximum force (+23°C)	-	N	ISO 6603-2
Puncture energy (+23°C)	-	J	ISO 6603-2
Puncture - maximum force (-30°C)	-	N	ISO 6603-2
Puncture energy (-30°C)	-	J	ISO 6603-2

Although this exercise did introduce students to the methods of searching for information, the published values of properties vary somewhat from reference to reference and they also vary with grade of polymer resin. The object was to have the students draw conclusions regarding the relationship of the polymers, and this variation added an unnecessary and undesirable complication. The issue of having several values for the same property frustrated and confused students who were accustomed to the “right answer” being available in the back of the text.

Example 2 - Polymer Replacement Resins

In the same sophomore survey course in polymers described above, a second information gathering problem was presented to the students. This involved engineering thermoplastics, as opposed to the commodity thermoplastics in the example above. The students were challenged to find the basic properties of a commercial resin and to define a substitute for the resin from another manufacturer.

Figure 4 - Student Assignment Sheet, Replacement of Engineering Thermoplastics

Zytel	Ultramid	Durethan	Other	Characteristics
E101L				
7300				
70G35HSL				
70G35HSLX				
80G25				
FR7200VOF				
330				

In this assignment the students were given a list of Dupont polyamide (Zytel™) resins and tasked to identify the unique properties of these resins and cross reference them to resins available from BASF (Ultramid™), Bayer (Durethan™), and another manufacturer of their choice (Figure 4).

This exercise forced the students to relate a commercial product back to the attributes that had been discussed in class, such as impact resistance, structure of the polymer (nylon 6 vs. nylon 6,6), etc. Next the students took those properties and found a material from the other suppliers that offered similar characteristics and performance.

Again the information was available in print format, but was a bit more obscure and harder to find. All of the students who were successful with this assignment used the Internet as an information source.

Students generally took one of two approaches to solving this problem. The first was to use the “Campus Web View”[4] site as described above. Figure 5 illustrates part of the information for Zytel™ 70G35HSLX. This information provided the students with the type of polymer (polyamide 6,6) which provided the basis of another search in the other manufacturers listing. It also gave the unique characteristics of this particular resin (35% fiber reinforce, heat stabilized, etc.), allowing a cross-reference. With these properties identified the student could identify a similar product from another manufacturer.

The other path taken by students was to use a service called “Prospector Web”[5]. This was a commercial program on the Internet that is subscriber based and costs approximately $10 per login to use. Fortunately a student package was included with the text used in the course (Plastic Materials and Processing, Brent Strong) [6]. This allowed students to log in a total of 15 times at no cost. This site allowed students to directly search for alternate vendors for a given polymer.

Figure 5 - Dupont Zytel™ Information

ZYTEL 70G35 HSLX NC-10^ PA 66 DuPont Engineering Polymers / Europe - 06/97

All data is subject to the producer's disclaimer.

Single-point data Multi-point data Other Text Information

Product text [ZYTEL 70G35 HSLX NC-10^]

```
HEAT STABILISED
35% GLASS FIBRE REINFORCED
EXCELLENT HYDROLYSIS RESISTANCE
DAM = DRY AS MOULDED
Applications: fuel rail, air filter housing
```

Processing and delivery form
Injection Molding; Pellets

Additives
Release agent; With fillers

Special Characteristics
Heat stabilised or stable to heat

Single-point data [ZYTEL 70G35 HSLX NC-10^]

Rheological properties [ZYTEL 70G35 HSLX NC-10^]

This exercise worked very well for the students and accomplished the goal of relating classroom principles to actual commercial materials.

One weakness identified in this exercise was in allowing the student to select one of the alternate vendors (Other column in Fig. 4). Leaving one vendor open did not significantly add to the students experience and placed a much greater burden on the instructor in grading.

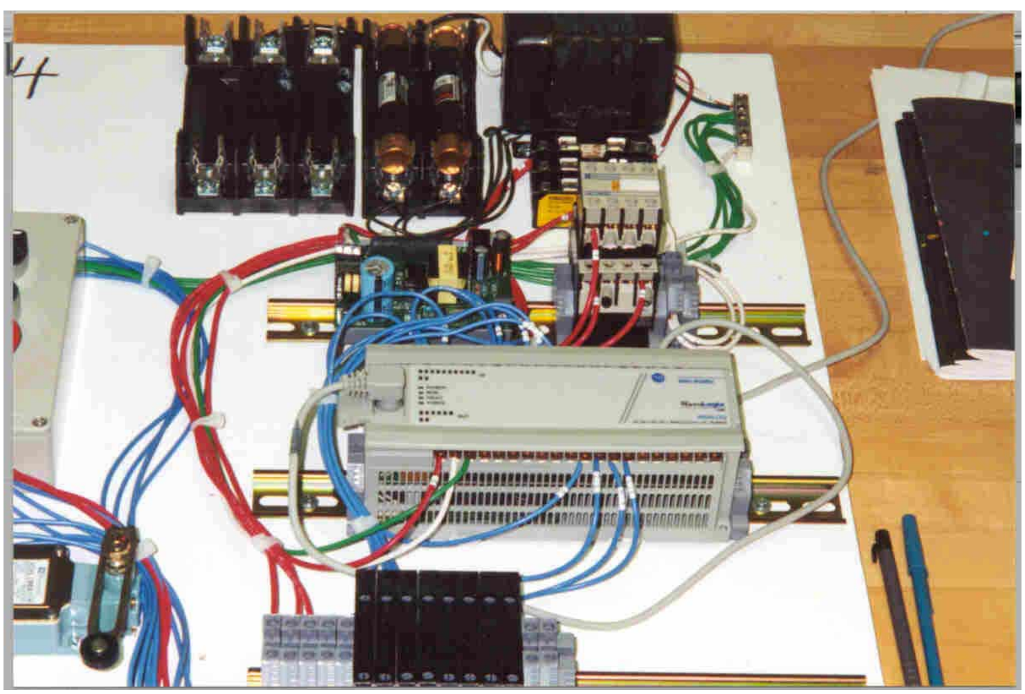
Example 3 - Industrial Controls - Design Simple Conveyor System

The third example of use of the Internet comes from another sophomore level class in Manufacturing Engineering Technology. The course title was Programmable Logic Controllers and covered programming, peripherals, and applications of PLC's. Two manufacturers of equipment were used in the course, Allen Bradley[8] and Koyo (AutomationDirect)[7]. The actual hardware and software for the student workstations were obtained from these two companies and both companies maintained extensive websites that contain user manuals and catalogs. The students appreciated having the equipment manuals available either on line or in as downloadable PDF files. This allowed them to find specifics on instructions for the PLC at home, work, or wherever they were doing homework.

The course work requirements were designed to encourage the students to refer to the equipment manuals in addition to the text. Although a complete set of manuals was available in the laboratory they were seldom used, as it was more convenient for the students to simply download and personalize their own copy.

During the course several small design projects were assigned to allow students to exercise their new programming skills and to tie the theory to actual equipment and applications (see Material Handling Work Cell Design Problem below). The students designed the system, specified the components, and wrote and tested the program. The programs were tested on a lab trainer where inputs were simulated by switches and outputs (solenoids, motor starters, etc) were simulated by pilot lights (Figure 6).

Figure 6 - PLC Trainer

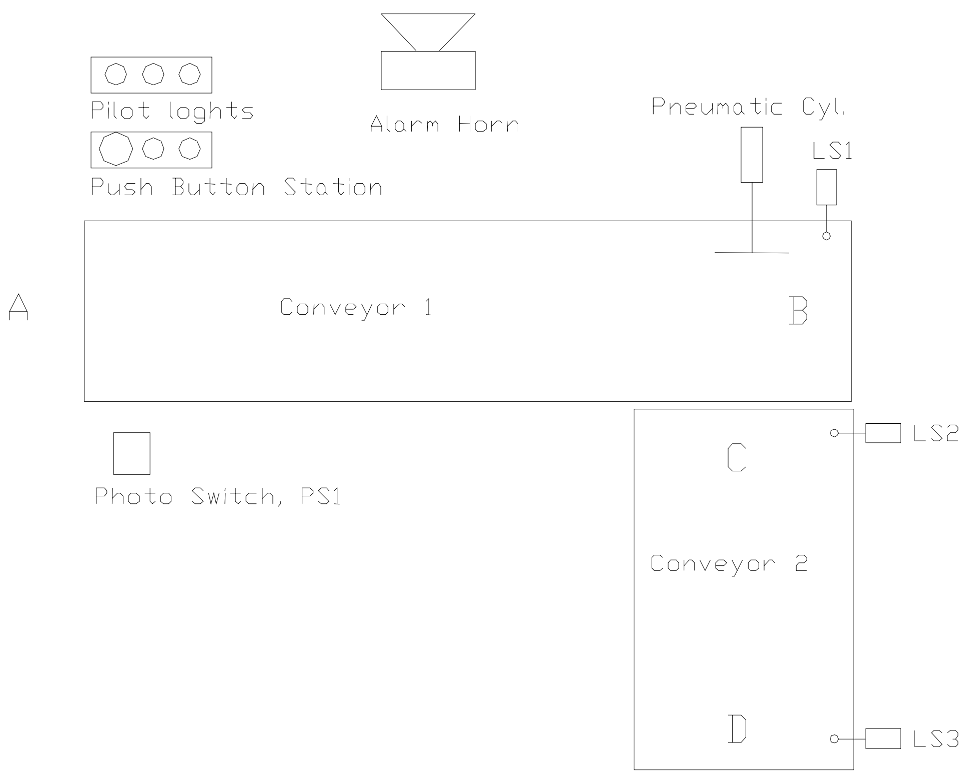


Material Handling Work Cell Design Problem

Design a system to implement the following control scheme (see figure below);

- When a box is placed at position A, conveyor 1 automatically starts and runs until the box is at position B,
- When the box arrives at position B, conveyor 1 stops, a solenoid causes the pneumatic cylinder to push the box to position C, and conveyor 2 runs as long as LS2 is made.
- After 3 boxes have been transferred to conveyor 2, conveyor 1 and the pneumatic cylinder are disabled and the boxes are moved to position D. When the last box is at position D conveyor 2 stops, and the green pilot light flashes until the boxes are removed,
- The operator presses a NC push-button to reset the system after the three boxes are removed.

Use a PLC Direct DL205 PLC with a D2-250 CPU and DC I/O modules. All the limit switches are NO. The push button station contains an E-Stop, a NO PB, and a NC PB. The Pilot light panel contains red, green, and yellow pilot lights. The photo switch is a retro reflective switch, i.e., the contacts open when a box is at position A. Draw the PLC and I/O electrical control circuit and the PLC logic. Specify all the switches from the Automationdirect.com catalog.



These design projects worked out extremely well and received very good reviews from the students. At the end of the course the students felt confident about their ability to tackle actual design projects.

An added benefit from these exercises was to familiarize the student with the process of specifying an actual control device (for example, a switch) from a catalog. The Automationdirect.com[7] web site contains, in addition to the Koyo PLC's, a selection of sensors and switches as illustrated below.

Figure 7 - Examples of Automationdirect.com Sensor Catalog

Path: Sensors & Encoders > MICRO SWITCH NEMA Limit Switches (Honeywell) > **Lever type**

NEW! LSK1A-8C	Stainless steel coil spring lever limit switch, 5.5 inch actuator, SPDT Double break momentary contacts, plug-in, 1/2 inch conduit. SPDT=single pole double throw. **Note:** All switches with wobble lever heads are operated by any movement, except direct pull. **Note:** Actuator IS included on operating head.	US$ 70.00
NEW! LSJ1A-7A	Plastic rod lever limit switch, 5.5 inch actuator, SPDT Double break momentary contacts, plug-in, 1/2 inch conduit. **Note:** All switches with wobble lever heads are operated by any movement, except direct pull. **Note:** Actuator IS included on operating head.	US$ 68.00

Having the students prepare a materials list as a part of the project added a sense of total cost versus value to the project. This is a large benefit to the student in applying their knowledge to real world applications

Conclusion

Three examples of the use of the Internet to add to a traditional course offering were shown.

These were largely successful and added to the student's educational experience without adding expense to the student or the school and without adding to the workload of the instructor. They allowed the students to build skills in accessing actual design information and integrating them into the practice of analytical skills.

Some keys to success in using the Internet as a source in projects were;

- Use a series of smaller projects through the semester. This allows students to absorb their success and/or failure and apply it to the next project.
- Control "fuzzy" data. Although commercial sources of information will have some variation and students must learn to deal with it, too much early in the process does more harm than good (see Example 1).
- Give students a head start, or a push in the right direction. One way of accomplishing this is to have a list of web sites that the student can explore to find information.

References

1. Modern Plastics Magazine, *Modern Plastics World Encyclopedia,* Chemical Week Associates, New York, NY
2. *Plastics Technology Magazine*, Gardner Publications, New York, NY
3. URL: http://www.plasticstechnology.com/, *Plastics Technology Online*
4. URL: http://www.m-base.de/wv1_03/index.html, *CAMPUS® WebView***,** Chemie Wirtschaftsfoerderungs-Gesellschaft Frankfurt/Main, Germany
5. URL:http://www.ides.com/, Prospector™ Web IDES Corporation, Laramie, Wyoming
6. Strong, Brent, *Plastic Materials and Processing, 2nd Edition*, Prentice-Hall, Inc, Upper Saddle River, NJ
7. URL:http:/automationdirect.com, Automationdirect.com Web, Cumming, GA
8. URL:http://www.ab.com/, Allen Bradley Web Site

JOHN ANDERSON

John Anderson is an Assistant Professor of Mechanical Engineering Technology at Purdue University. He is a registered Professional Mechanical Engineer in Nevada and received B.S. and M.S. degrees in Mechanical Engineering from the University of South Carolina. Prof. Anderson is currently teaching in the areas of manufacturing automation and polymer manufacturing and is active in working with industry.