# Using Globalspec<sup>®</sup> in the Classroom

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#### 1. Abstract

In this paper, Globalspec, a web-based engineering tool and search engine, is introduced GlobalSpec simplifies the task of specifying engineering parts and components by using powerful parametric searches. GlobalSpec presents detailed product information provided by broad base of manufacturers of optical components, mechanical parts, electrical products, semiconductors, materials, manufacturing systems, instruments, sensors, process systems and many other industrial product areas. The authors presents the techniques used in two classes where the students select components for engineering designs using the tools available at Globalspec. The design details will be discussed along with the design examples. Also outlined are the powerful resources GlobalSpec provides for engineering users or students to explore or learn about products and their specifications.

#### 2. Introduction

Globalspec (<u>www.globalspec.com</u>) is an Internet-based engineering search engine and the largest online database of technical catalog. Users can search the large engineering database of technical component by specifications, part numbers, patents, application notes, government and industry standards, and thousands of manufacturers. Since its inception in 1996, Globalspec has seen a steady increase in registered engineers and technical buyers that daily use the free service to look for part specifications for design, testing and other purposes.

Globalspec has become a one-stop location where engineers and technical buyers meet, and can search for products, services, technical articles, standards, application notes, and more. Globalspec has amassed the largest online community of engineers and technical professionals in the history of the Internet with over 1.3 million registered users at the time of this writing. Nowadays engineers and technical professionals use the Web throughout their work process to search for and locate products and services, learn about suppliers and access comprehensive technical content on standards, patents, design, specifications, materials, application notes, and many other important activities in the daily life of and engineer. Without Globalspec, or a tool similar to it, the essential task of locating a specific component for a design would take many hours of browsing in manufacturer's catalogs.

All these tasks are accomplished by just linking to the Globalspec site. This is the reason why many engineers at important industrial manufacturers as well as research laboratories

use the Globalspec site for all engineering tasks. Organizations where GlobalSpec is used include 3M, IBM, Motorola, Alcatel, Boeing, Cisco, NASA, Fermilab, Nokia, Intel, National Instruments, Siemens, Lucent, Los Alamos National Laboratory, and many more. The engineering community, represented by engineers at these companies require a specialized search engine offering precise, relevant results and easy access to the comprehensive engineering-related information to succeed in these times with shortening product design and development cycles.

3. Finding Engineering Components with GlobalSpec

For last four years, techniques in using Globalspec's area specific advanced search technology, SpecSearch®, have been taught in engineering technology classes at Hudson Valley Community College. Methods provide students new tools to deliver accurate parts for design purposes. With Globalspec, users can search by specification more than 75 million parts representing over 1.2 million product families from more than 13,000 supplier catalogs. By using the Globalspec search capabilities and tools, engineers can save countless of hours of non-productive time because there is no need to use the old way of manually searching for precise products attributes by browsing print or PDF catalog after catalog for many hours, in order to find the precise electronic part needed for my project. Often individual suppliers present their product specifications using different formats or terminology. On GlobalSpec, specifications and features are standardized within an area, which facilitates faster head to head product comparisons.

A typical part search using Globalspec can be summarized in the following steps:



1. Link to Globalspec (<u>www.globalspec.com</u>). See Figure 1, below.

Figure 1: Globalspec Main Page

2. Enter the component you are looking for (Op-amp, Temperature Sensor, Transistor, FPGA, Analog-to-Digital Converter, Bluetooth Chips, etc.) in the "Find" box and select "Go" or enter. Alternatively, a user more experienced with the GlobalSpec site can browse through the taxonomy of industrial product categories.

3. Step 2 will bring an area or product specific advanced search form (or filter) and a list of manufacturers. At this point you may select a company that manufactures the component or you may want to narrow your part search by selecting parameters from the filter, as shown below in Figures 2 and 3. The search specifications shown are for a Power MOSFET where values of the drain breakdown voltage V<sub>(BR)DSS</sub> (at least 15.00 volts) and the steady state drain current I<sub>DSS</sub> (at least 12.00 mA) are required. Note that all the specifications in the filter have a "No Preference" default value. This feature allows engineers to search for the most important or most needed parameters.

		Online C	ustom
Enter one or more Gener	al Specifications cr	iteria:	
Polarity:	<b>☑ No Preference</b> ■ N-Channel ■ P-Channel	Complementary	Help
Operating Mode:	✓ No Preference ■ Enhancement		Help
Power MOSFET Type:	✓ No Preference ■ DMOSFET	Other	Help
Production Status:	No Preference Full Production Discontinued In Development	□ New Product □ Other	Help
(Cancel)	Update	Results	

Figure 2: One section (General Specifications) of Power MOSFETs Filter

l	Compare Selected	Catalogs   Send Group E-mail	
Select	Online Catalog Co	npany	Head
Enter o	ne or more Perfor	mance criteria:	Low
V <sub>(BR)</sub>	DSS <sup>.</sup>	At least 15.00 volts 💌 Help	Lexii San
r <sub>DS(0</sub>	n) <sup>.</sup>	No more than No Pref. 🛛 ohms 🛛 🛛 🗠 🗠	Jan
I <sub>DSS</sub> :		At least 12.00 milliamps 👻 Help	
Q <sub>g</sub> :		No more than No Pref. nC 💌 🔫	
P <sub>D</sub> :		No more than No Pref. 🛛 milliwatts 🛛 🔫 💷	
T <sub>J</sub> :		From No Pref. To No Pref. C 🗸 Help	
	( Cancel )	Update Results	

Figure 3: Another Section of the filter (Performance Criteria)

4. After selecting the required specifications, a list of manufacturers that sell the specified component will be shown. By selecting one of the manufacturers a *catalog or matching table* will present the results, as shown in the Figure. The matching table will show all the components from the selected manufacturer. In the example 717 power MOSFETs were found from STMicroelectronics, Inc. that fit our search criteria. The component selections can be narrowed down by selecting an N-type MOSFET with a power dissipation (P<sub>D</sub>) of no more than 30.00 Watts using the input search filter shown in Figure 3. This new set of criteria will produce a matching table for STMicroelectronics of only 19 products instead of the original 717. See Figure 5.

Power M STMicro	AOSFET electronics,	<u>Inc.</u>										
oices? <u>Filt</u>	er your results											
15 of 717	that meet you	r specifications	Page: 1 <u>2 3 4 5</u>	<u>678910</u> N	ext»							
elections N	ow											-
	Get Pro	duct Information	Cor	ntact the Manufact	urer		General Spe	cifications				
<u>'roduct</u> <u>tames</u>	Product Spec Sheet	Info on Company Web site	Request for Quotation	Order Sample	Send an E-mail	<u>Polarity</u>	MOSFET Operating Mode	Production Status	<u>Type</u>	V <sub>(BR)</sub> DSS (volts)	I <sub>DS(on)</sub> (ohms)	(mi
000	<ul> <li>See specs</li> </ul>	Go to Web site	Request quote	Order Sample	Send E-mail	N- Channel		Full- Production		<mark>60.00</mark>	5.00	
002	<ul> <li>See specs</li> </ul>	Go to Web site	Request quote	Order Sample	Send E-mail	N- Channel		Full- Production		<mark>60.00</mark>	5.00	
520	<ul> <li>See specs</li> </ul>	Go to Web site	Request quote	Order Sample	Send E-mail	N- Channel		Full- Production		<mark>100</mark>	0.1300	ł
530	• See specs	Go to Web site	Request quote	Order Sample	Send E-mail	N- Channel		Full- Production		<mark>100</mark>	0.1600	ł
540	• See specs	Go to Web site	Request quote	Order Sample	Send E-mail	N- Channel		Full- Production		<mark>100</mark>	0.0700	8
520	• See specs	Go to Web site	Request quote	Order Sample	Send E-mail	N- Channal		Full- Production		<mark>200</mark>	0.8000	•
<			1111									>

Figure 4: Matching Table for criteria V<sub>(BR)DSS</sub> at least 15 V, and I<sub>DSS</sub> at least 12.00 mA

Catalo fr	og: Power i om: <u>Univers</u>	NOSFE I al Semicond	uctor, Inc.						
Too mar	y choices? Fil	ter your results							
Product	s 1 - 15 of 19 t	that meet your	specifications P	age: 1 <u>2</u> Next»					
Comp	are Selections N	ow ]							
		Get Proc	luct Information	Contact the	Manufacturer		General Specific	ations	
Select:	<u>Product</u> <u>Names</u>	Product Spec Sheet	Info on Company Web site	Request for Quotation	Send an E-mail	<u>Polarity</u>	<u>Operating</u> <u>Mode</u>	<u>Type</u>	Ч
	SD1107BD	<ul> <li>See specs</li> </ul>	<ul> <li>Go to Web site</li> <li>View PDF</li> </ul>	<ul> <li>Request quote</li> </ul>	<ul> <li>Send E-mail</li> </ul>	<mark>N-</mark> Channel, P- Channel*, Comp*	Enhancement	DMOSFET	
	SD1107DD	See specs	<ul> <li>Go to Web site</li> <li>View PDF</li> </ul>	<ul> <li>Request quote</li> </ul>	<ul> <li>Send E-mail</li> </ul>	<mark>N-</mark> Channel, P- Channel*, Comp*	Enhancement	DMOSFET	
	SD1107HD	<ul> <li>See specs</li> </ul>	<ul> <li>Go to Web site</li> <li>View PDF</li> </ul>	<ul> <li>Request quote</li> </ul>	<ul> <li>Send E-mail</li> </ul>	<mark>N-</mark> Channel, P- Channel*, Comp*	Enhancement	DMOSFET	
	SD1117BD	<ul> <li>See specs</li> </ul>	Go to Web site	Request quote	<ul> <li>Send E-mail</li> </ul>	N-	Enhancement	DMOSFET	

**Figure 5:** Table for criteria N-type MOSFET, V<sub>(BR)DSS</sub> at least 15 V, I<sub>DSS</sub> at least 12.00 mA and P<sub>D</sub> of no More than 30.00 watts

"Proceedings of the 2005 American Society for Engineering Education Annual Conference and Exposition Copyright © 2005, American Society for Engineering Education" 5. To look at a particular component or part from the matching table, press the *View PDF* or *Go to Web site* link for the part required, and the precise specification page of the manufacturer's catalog or datasheet will be presented, as is shown in Figure 6. This selection corresponds to the first component listed in Figure 5.

Universal Semi	conductor	SD1107/1117 N CHANNEL ENHANCEMENT MODE DMOS POWER FETS
FEATURES . Gate Standoff Voltage . Available in a wide variety of packages . Low capacitances . Low ON resistance . P-Channel Complement Available,	APPLICATIONS . High Speed Pulse Amplifier . CMOS Logic to High Current . High Speed Switching . Line Drivers	Interfaces
ABSOLUTE MAXIMUM RATINGS (TC = 25°C	unless otherwise noted)	
Drain-Source Voltage	1001	
SD1117	60V	
Drain-Gate Voltage (BGS = 1M)		
SD1107	100V	
SD1117		
A A	1.1017	

Figure 6: Manufacturer's PDF file of selected part from Figure 5

As you can see, this process takes less time and it is more accurate than catalog searches or searches using generalized web-based search engines. While GlobalSpec is an indispensable tool for engineering design work, faculty may also find the GlobalSpec site useful for R&D projects, consulting work and developing student lab exercises. Over time, the actual search results will may vary from the examples shown as new component suppliers are added into the Globalspec database and site content changes.

The next section of this paper will present a simple student project where Globalspec search engine plays an important role in *bringing the final product to the market* in a short period of time. In particular, the solutions to the following project are detailed: The design Class B Power Amplifier.

4. Class B Power Amplifier Design



Figure 7: Class B Power Amplifier

Figure 7 represents the circuit of a Class B Push-Pull Power Amplifier. An analysis of this circuit shows that the amplifier has a voltage gain of unity. If an input voltage  $V_i = 12 V_{rms} (V_{i(p)} = 17 V)$  is assumed, then the peak value of the output voltage will be  $V_{L(p)} = 17 V$  as well. If an  $R_L = 4 \Omega$  si chosen, then the following can be determined: output power across the load ( $P_{O(ac)}$ ), the peak load current ( $I_{L(p)}$ ), the dc current from the supply ( $I_{dc}$ ), the dc input power ( $P_{i(dc)}$ ), and the power dissipated by each transistor ( $P_Q$ ) as follows:

 $P_{O(ac)} = V_{L(p)}^{2} / 2R_{L} = 36.125 \text{ W}$  $I_{L(p)} = V_{L(p)} / R_{L} = 4.25 \text{ A}$  $I_{dc} = 2 I_{L(p)} / \pi = 2.71 \text{ A}$  $P_{i(dc)} = V_{cc} I_{dc} = 67.75 \text{ W}$  $P_{O} = (P_{i} - P_{o}) / 2 = 15.8 \text{ W}$ 

In order to build the circuit using real standard parts found in the industry, the students were asked to find the part numbers and the manufacturers of those parts found in the real world. The most important parameters in this simple case are the bias current and the power dissipation of the transistors. The transistors should be able to stand a bias current ( $I_{dc}$ ) of at least 2.71 A and dissipate at least 15.8 W. To be in the safe side, let's choose as our goal values of 3.00 A and 30.00 W for the current and power respectively of the transistors. The corresponding parts can be found using the parametric search for Bipolar Power Transistors found in the Globalspec site. Figures 8 and 9 show the parametric search criteria and the resulting matching table generated when selecting Shindenhen America, Inc. as the supplier.

Select	Online Catalog	Company		Headquarters
Enter	one or more Pe	rformance criteria		
h <sub>fe</sub> :		At least No P	ref. No more than No Pref.	Help
$\vee_{cec}$	j.	At least No P	ref. volts 💌	Help
∨ <sub>свс</sub>	j.	At least No P	ref. No more than No Pref.	volts 💌 Help
l <sub>C(ma</sub>	×) <sup>.</sup>	At least 3.00	amps 💌	Help
f <sub>T</sub> :		At least No P	ref. MHz 🖌	Help
P <sub>D</sub> :		No more that	30.00 watts 💌	Help
Powe	er Gain:	At least No P	ref. dB	Help
Outp	ut Power:	At least No P	ref. 🛛 watts 🖌 🖌	Help
T <sub>J</sub> :		At least No P	ref. No more than No Pref.	C 🖌 Help
		ancel	Update Results	

Figure 8: Parametric search criteria.

You are <u>Global</u>	e here: <u>Spec.com</u> > <u>S</u>	emiconductors	> <u>Transistors</u> > <u>Pow</u>	<u>ver Bipolar Transi</u>	<mark>stors</mark> > Shindeng	en Ameri	ica, Inc.		Your Stuf	f   Your
Catal fi	og: Power E rom: <u>Shinden</u>	Bipolar Tran Igen America	isistors a <u>, Inc.</u>							
Too mai	ny choices? <u>Filt</u>	<u>er your results</u>								
Produc	ts 1 - 15 of 16 t	hat meet your	specifications P	age: 1 <u>2</u> Next»						
Comp	are Selections N	ow								
		Get Proc	luct Information	Contact the	Manufacturer		Transistor			
Select:	<u>Product</u> <u>Names</u>	Product Spec Sheet	Info on Company Web site	Request for Quotation	Send an E-mail	<u>Polarity</u>	<u>Grade /</u> Operating <u>Range</u>	<u>h</u> te	⊻ <sub>ceo</sub> (volts)	⊻ <u>c</u> (vol
	FS Series 2SC4663	<ul> <li>See specs</li> </ul>	<ul> <li>Go to Web site</li> <li>View PDF</li> </ul>	<ul> <li>Request quote</li> </ul>	<ul> <li>Send E-mail</li> </ul>	NPN	Commercial, Industrial, Automotive	10.00	200	25
	FS Series	• See specs	Go to Web site	• Request quote	• Send E-mail	NPN	Commercial	10.00	200	25

Figure 9: Matching table for search criteria of Figure 8.

Sixteen part numbers satisfy these criteria. A side effect of using Globalspec for the students is the fact that by accessing the parametric search filters they will be able to look at most of the important parameters of engineering components. While this example was only concerned in finding a transistor with certain bias current and certain power dissipation, the search filter (see Figure 8 above) contains the description of other important parameters related to power BJT transistors. Searching students or users can access and study help descriptions of each parameter available in the parametric search. This feature of Globalspec is particularly useful in a teaching or academic environment.

Additional features available at Globalspec website, which can be used as tools for teaching technical matters, are described in the next section of this paper.

5. Product Exploration and Learning with GlobalSpec

Beyond gaining the ability to perform parametric searches to find and select the correct components needed for a new design, engineering students can learn a great deal by browsing through the GlobalSpec site. The site provides many opportunities for users to explore and learn about technical products. The following sub-sections introduce some of these tools that can be accessed through the main GlobalSpec page.

 Product Categories – Product or components are organized in a technology based taxonomy or directory. A tour through the sections such as <u>Bearings</u>, <u>Motors</u>, <u>Temperature Sensing</u>, <u>Diodes</u> or <u>Vacuum Equipment</u> will provide a new engineer or student an indication of the common types of components used in industry along with short descriptions of these products or components. The following caption is for the products related to Bearings and Bushings:



2.) "Learn more about" pages – By drilling down deeper into specific categories and selecting a "Learn more about" link for an area, students can delve further into a particular component, service or product type. "Learn more about" pages provide a more in-depth description with additional details of the product or component.

a.	Learn more	about	Ball	Bearings.	See the	following figure:	
----	------------	-------	------	-----------	---------	-------------------	--

Find Ball Bearings, All Types, ball bearing, wheel bearing, plastic bearing, types bearing, bea - Microsoft Internet Explorer	_ <b>- - - - - - - - - -</b>
File Edit View Favorites Tools Help	
🛛 🖸 🚱 Search Web 👻 🚳 🔤 🖓 🖓 🖓 🖓 🖓 🖓 🖓 🖓 Search Web 🔹	
Links 👸 GlobalSpec.com 🍘 Overture- Tool 🔮 Online Conversion 🍘 Merriam-Webster 💌 Test_New_Area 🍘 Conversions 🍘 Encyclopedia 🍘	News for Nerds 🍓 Spectrum 💙
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Address 🕘 http://ball-bearings.globalspec.com/LearnMore/Mechanical_Components/Bearings_Bushings/Ball_Bearings_All_Types	<b>▼</b> ∂⊙
<mark>G L O B A L S P E C<sup>®</sup></mark> The Engineering Search Engine	
Emityoursearch to:	
You are here: <u>GlobalSpec.com</u> > <u>Mechanical Components</u> > <u>Bearings and Bushings</u> > <u>Ball Bearings, All Types</u> > Learn More	Your Stuff   Your Profile
About Ball Bearings, All Types	
Show all Ball Bearings, All Types companies	
Ball bearings are used to provide smooth, low friction motion in rotary applications. Ball bearings types include Radial Ball Bearings (Deep Groove and Angular	Of Interest
Contact) and Thrust Ball Bearings. Radial ball bearings are designed to carry both radial and axial (thrust) loads, while thrust ball bearings are designed for pure thrust loads only. Radial, or deep groove bearings, can take radial and axial loads to varving degrees but are used when the primary load is in the radial	Related to Ball Bearings, All Types
direction. They consist of an inner ring, an outer ring, balls and sometimes a cage to contain and separate the balls. Angular contact ball bearings are designed	Search the Engineering Web
such that a contact angle between the races and the balls is formed when the bearing is in use. The major design characteristic of this type of ball bearing is that one or both or the ring races have one shoulder higher than the other. In order for these bearings to function properly, they must be assembled with a	Search By Part Number (Beta)
thrust load. This loading (or preload) creates a line of contact (or contact angle) between the inner race, the ball and the outer race. The preload can be built in to the bearing or created when the bearing is inserted into an assembly. The contact angle varies from 15° to 40° and is measured relative to a line running	Application Notes
perpendicular to the bearing axis. Angular contact bearings are one-directional thrust bearings that can withstand heavy thrust loads and moderate radial	Find Product Announcements for Ball Bearings, All Types
Industs in the ball bearings are designed to put a time balls. These bearings can handle multiply or advant balls. The form of the bearings can be a ball, needer, or roller. Slewing ring or turntable bearings can accommodate axial, radial and moment loads. They are not mounted in a housing or on a shaft, but instead are mounted directly to a seating surface. The inner and outer rings are supplied with mounting holes. The inner ring, outer ring, or both may have integral gears. These bearings are referred to as tabletop bearings, turntable bearings, and slewing rings.	PRODUCT ANNOUNCEMENTS
Important dimensions to consider when specifying bearings include bore, outside diameter, and overall width. The bearing industry uses a standard number system for bearings with metric diameter bores. For bore sizes 04 and up multiply by 5 to obtain the bore in millimeters. If the bore is a hex this refers to the dimension across the flats. If the bore is tapered this refers to the smaller diameter. The outside diameter of the bearing includes the housing if a housed unit, but excludes the flatge if a flanged bearing. The outer ring width is the overall width of the outside of the bearing. The overall width of the bearing to bearing assembly includes the locking collar, if present. Important operations so consider when searching to relearing include rated speed, dynamic axial	
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- b. Learn more about DC Motors
- c. Learn more about Dial Thermometers
- d. Learn more about Diodes
- e. Learn more about Vacuum Flanges and Fittings
- 3.) Specification Pages or Help Links The young engineer, scientist or technologist can gain a better understanding of the specifications or attributes for a particular component or product by accessing Specifications pages located at the bottom of the "Learn more about" pages (use Ctrl+End or scroll to the bottom the Learn more about page selected). Often an engineer or student new to an area does not know where to start or how to narrow searches because the specifications or attributes are unfamiliar. Help links to these specifications guides are also provided in the parametric advanced search forms.

"Proceedings of the 2005 American Society for Engineering Education Annual Conference and Exposition Copyright © 2005, American Society for Engineering Education" a. <u>View Ball Bearings Specifications</u>. See the following caption:



- b. <u>View DC Motors Specifications</u>
- c. View Dial Thermometers Specifications
- d. View Diodes Specifications
- e. View Vacuum Flanges and Fittings Specifications
- 4.) <u>Application Notes</u> Users can also search for product specific white papers or application notes to gain a better understanding of the use or implementation of a product or component in certain designs, under specific industrial conditions or within larger engineering systems. These documents may list detailed design specifications, as well as data describing how the product functions in different situations.

http://application-notes.globalspec.com/Search/ApplicationNoteSearch



5.) Engineering Web<sup>SM</sup> Searches – Web searches using the GlobalSpec search engine will return results more pertinent to the young engineer compared to the general-purpose search engines. An Engineering Web<sup>SM</sup> search for "Pumps" will return links on industrial pumps, while a search on a general-purpose search engine returns results high heeled shoes. An Engineering Web<sup>SM</sup> search for "strippers" will return links on cleaning agents or chemicals as one would expect, while a search on a general purpose search engine returns results, which educators hope are not of interest to good engineering students.

http://search.globalspec.com/Search/WebSearch

gl(c • ♥ (Search Web • Ø) Parent Baczs blocked "Grunofil O Paloptons // @GlobalSpec.com @Overture-Tool @Online Conversion @Merriam-Webster ®Test_New_Area @Overversions @Encyclopedia @News for Nerds : ▼ > ↓ ← Back • → • @ ② ⑦ ↓ @Search @Favorites @Media ③ 日 • ④ W • 回	Spectrum
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The Engineering Web - a slice of the World Wide Web focusing solely on engineering and technical content	
Part Numbers - a web-based search limited to manufacturer and distributor sites	
Application Notes - more than 225,000 application notes searchable by keyword or phrase	
Material Properties - critical information for designers	
Standards - the world's largest file of active and historical standards specifications drawings handbooks	
Patents - a digital collection of patents, patent applications and grant information	
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#### 6. Conclusion

In conclusion, engineering hubs and search engines such as GlobalSpec provide a wealth of tools to enable engineers to perform their jobs more efficiently. The GlobalSpec website also contains many useful resources for educating engineering and technology students. Proficiency in online searching of industrial components is a useful skill for new engineers to acquire and can be integrated into engineering curricula. Further study is required to quantify the impact of search tools like GlobalSpec in enhancing engineering education. Anecdotally, several graduates now in industry have reported back that they use GlobalSpec frequently and instruction in using the search tool was an advantage. A system that speeds access to technical information should be a beneficial resource for engineering students as well as practicing engineers.

### 7. References

- 1. Boylestad, Robert L. and Nashelsky, Louis. *Electronic Devices and Circuit Theory*, 7<sup>th</sup> edition, Upper Saddle River, NJ: Prentice Hall, 1999.
- 2. http://www.globalspec.com/SiteMap

## 8. Biographical

Abraham Michelen is a full professor in the Engineering Technology Department at Hudson Valley Community College. Abe has a Ph.D. in Electrical Engineering from Rensselaer Polytechnic Institute as well as M.S. degrees in Nuclear and Electric Power Engineering. Gary Kardys is an adjunct faculty in the Engineering Technology Department at Hudson Valley Community College. Gary has M.S. and B.S. degrees in Metallurgy and Materials Engineering from Rensselaer Polytechnic Institute.