AC 2010-64: PERCEPTIONS IN THE MANUFACTURING EDUCATION COMMUNITY

Hugh Jack, Grand Valley State University

Hugh Jack is a Professor in the School of Engineering at Grand Valley State University in Grand Rapids Michigan. His interests include Product Design and Manufacturing Engineering, with a particular focus in control systems.

Perceptions in the Manufacturing Education Community

Abstract

A number of studies have been conducted to assess the status of manufacturing education. These focus on the departments and schools specifically. There is a need for a complementary study of the opinions of manufacturing educators. This paper describes a study of self-identified individuals with interests in manufacturing education. The survey results examine the perceptions of the past, current, and future of the field. In particular teachable topics, pedagogical methods, industry needs, and the future of programs.

Introduction

The survey addresses two major themes, attitudes about manufacturing education and curriculum content. The content of the survey was shaped by the authors experiences in SME organized forums and a summit[1, 2, 3]. The survey is also designed to compliment previous studies that look at Manufacturing Programs[4, 5, 6], as opposed to the opinions of individuals.

The survey was offered in a brief format to increase response rates. The trade off is that it the results are less specific. However the results of the survey can lead to further surveys.

Survey Respondents

The survey was sent to a private email lists of individuals who have been identified through the SME and ASEE Manufacturing Division (approx. 400), and an email list server for the Engineering Technology Division of the ASEE (approx. 1000). The early results of the survey shown below indicate a lack of input from manufacturing engineers and managers, researchers, and trade organizations. The small number of students is understandable given the distribution methods while the small number of consultants and trainers is reasonable given the general manufacturing demographics. Clearly the current results will have a bias towards manufacturing educators perspectives.

Your Role

Industry - Engineer	10	6%
Industry - Management	4	2%
Faculty - Instructor	76	47%
Faculty - Researcher	14	9%
Faculty - Administrator	38	23%
Consultant and/or Trainer	6	4%
Student	2	1%
Trade Organization or Group	9	6%
Other	3	2%

Where you work

Manufacturer	11	7%
College or University	126	78%
K-12 School	0	0%
Training Company	0	0%
Self Employed	5	3%
Manufacturer	11	7%
Trade Organization	9	6%
Other	11	7%

Years in Role

Less than 5 years	20
5 to 9 years	30
10 to 14 years	22
15 to 19 years	14
20 to 24 years	31
25 to 29 years	16
more than 30 years	14

The questions that examine the employer are reasonably correlated to the reported roles. And the years of service indicate that a broad spectrum of experience levels are involved.

General Attitudes

In general the respondents appeared to have a solid opinion of the benefits of manufacturing education on the economy. However, for social/political priorities, and the 'image of manufacturing' the responses were across the range of responses, centered on 'impartial'. There was a clear opinion that ties between industry and education will form.

In the coming years do you believe that US manufacturing and manufacturing education will help the economy

disagree	1	1%
impartial	8	7%
agree	108	92%

In the coming years do you believe that US manufacturing and manufacturing education will be a political priority

disagree	19	24%
impartial	31	39%
agree	30	38%

In the coming years do you believe that US manufacturing and manufacturing education will be a social priority

disagree	25	28%
impartial	47	52%
agree	18	20%

In the coming years do you believe that US manufacturing and manufacturing education will have a better image

disagree	16	21%
impartial	47	63%
agree	12	16%

In the coming years do you believe that US manufacturing and manufacturing education will improve education and industry ties

disagree	5	6%
impartial	30	38%
agree	43	55%

A crude conclusion that can be drawn from the data suggests that the respondents feel as if they will have an impact but are inconsistently receiving support or encouragement from outside the manufacturing community.

4. Curriculum Content

It is the authors experience that there are multiple opinions about what should be taught in the Manufacturing Curriculum. Ideally all of these topics would be included in a program. However the reality is that given the current time limitations adding new content requires the reduction/ removal of other content, development of new teaching methods, increase of degree time, post-graduation education, developing a specialized degree program, internships/cooperative educa-

tion/apprenticeships, project work, graduate studies, or other related changes. The author is not suggesting any approach over another. Variations in curriculum demands are typically related to regional manufacturing emphasis, state of the economy, demands for emerging knowledge, perceived needs, academic research interests, etc. The average of the results have been calculated using a value of 0 for 'eliminate' and '4 for major addition'.

Table 1: Education Questions by Topic

Education Topic	eliminate = 0	decrease = 1	no change = 2	increase = 3	major addition = 4	avg
Production Modeling	0/0%	7/4%	56/36%	86/55%	7/4%	2.6
Simulation	1/1%	5/3%	34/22%	93/59%	25/16%	2.86
Manufacturing Processes	0/0%	9/6%	57/36%	78/49%	14/9%	2.61
Product Design	0/0%	6/4%	47/30%	84/54%	20/13%	2.75
Materials	2/1%	4/3%	47/30%	77/49%	26/17%	2.78
General Fundamentals	0/0%	6/4%	87/56%	49/32%	13/8%	2.45
Sustainability/ Environmental	1/1%	7/4%	22/14%	79/51%	47/30%	3.05
Globalization	2/1%	10/6%	36/23%	69/44%	39/25%	2.85
Lean Manufacturing and related topics	1/1%	4/3%	48/30%	78/49%	27/17%	2.8
Quality	0/0%	8/5%	67/42%	63/40%	20/13%	2.6
Controls and Automation	1/1%	7/4%	58/37%	75/47%	17/11%	2.63
Bio/Medical Technology	2/1%	7/4%	31/19%	85/53%	34/21%	2.89
Nanotechnology	2/1%	5/3%	35/22%	77/48%	40/25%	2.93
Electronics	3/2%	8/5%	74/47%	64/40%	10/6%	2.44
Management Topics	2/1%	16/10%	84/53%	47/30%	9/6%	2.28
Teamwork	4/3%	12/8%	66/42%	59/37%	17/11%	2.46
Communication Skills	3/2%	1/1%	63/40%	63/40%	28/18%	2.71
Projects	2/1%	3/2%	62/39%	70/45%	20/13%	2.66
eLearning	2/1%	10/6%	58/37%	71/45%	17/11%	2.58
Postgraduation Learning	2/1%	7/4%	57/36%	75/47%	17/11%	2.62

The responses show a clear bias towards adding more of every topic to the curriculum with very few responses indicating a decrease in topical need. Some liberty was taken to do a rough ranking of topics by demand.

Sustainability/Environmental (avg. 3.05)
Nanotechnology (avg. 2.93)
Bio/Medical technology (avg. 2.89)
Simulation (avg. 2.86)
Globalization (avg. 2.85)
Lean Manufacturing and related topics (avg. 2.8)
Materials (avg. 2.78)
Product Design (avg. 2.75)
Communication Skills (avg. 2.71)
Projects (avg. 2.66)
Controls and Automation (avg. 2.63)
Post graduation education (avg. 2.62)
Manufacturing Processes (avg. 2.61)
Quality (avg. 2.6)
Production Modeling (avg. 2.6)
eLearning (avg. 2.58)
Teamwork (avg. 2.46)
General Fundamentals (avg. 2.45)
Electronics (avg. 2.44)
Management Topics (avg. 2.28)

Any future surveys examining topical content in manufacturing programs should ask for relative importance of topics.

5. Other Comments

The survey included a place for freeform comments. These are listed below with general observations for some as appropriate. In a few places editor comments are placed between '[' and ']' and some minor grammar errors have been corrected, otherwise the responses are as written.

The focus of the following comments have an emphasis on the practical nature of engineering education and a need to support the workplace. A number of respondents indicated specific topics and methods. In general the comments suggest that education must be tied to the needs of manufacturers.

[Industry Comment] Patents and how to protect IP should be taught to US manufacturing students

Addition of ethics and soft skills, such as emotional intelligence, work ethic, etc.

[Industry Comment] Entrepreneurship must be covered

Politically and Socially:

safety: both worker and product - remain the same. These comments are based on our programs.

The major problem in Manufacturing Education is that we have gone away from basic fundamentals. We have falling into a "trap" that has us looking for the hot topic rather than truly educating an individual that has the skills to learn and adapt to the new technology. We need to pattern ourselves more like the medical profession and less like NASCAR. Medical professionals have sound foundations in all of the sciences before beginning medical studies. Medical schools have no problem in filling and attracting the best. We continually "dumb down" and wonder why we can't fill our ranks. Let's openly exam our so called "best practices" and forget about saying what is needed to get the grant or be PC. The truth will set us free.

Education should not lose sight of what is needed in the factory to improve quality of products by investing in the best capital equipment and staying abreast with improving technology.

Industry needs professionals that can apply the new technologies with the correct applications. The US manufacturing base must stay strong in order for the country to compete along side other industrial nations.

THE MISSING LINK ARE INTERNSHIPS AND CO-OP OPPORTUNITIES... THIS IS WHERE THE FEDERAL GOVERNMENT CAN MAKE A CONTRIBUTION TO THE ECONOMY NOW AND IN THE FUTURE. COMPANIES NEED TAX INCXENTIVES TO HIRE INTERNS AND CO-OPS.

[name removed] Technology advancements have evolved so far that our current degree programs are no longer current with these advancements. To solve this we need to examine our graduates job roles and begin tailoring our programs to match theirs.

Probably less the way we've traditionally taught. More interactive learning and more problem-based learning that requires student learners to be more engaged in their learning. Less cramming for the next test. More demonstration of concept mastery by the learner. More facilitation of the learning process by the faculty. Probably more applied problem-solving and research on open-ended problems.

The current technology or manufacturing degree programs are stuck with forty year or more education topics with many faculty teaching from text books that match. It is time to look into each program and decide how a topic teaches the

technology that a graduating student would use tomorrow on their first day in their new job role. If it doesn't support this than it should be considered for removal from the topics that do.

I think we are doing a good job providing the skills for manufacturing. However, we don't have enough students and parents that value careers in manufacturing at this time.

SME has failed to carry the status of the manufacturing engineer (MfE) to a national level. This is because none of the major colleges of engineering produce MfEs so the degree does not carry the respect and recognition of other engineering degrees (like ME, CE, EE, ChE) . The solution is to create MfE depts. in the major colleges of engineering and develop curriculum to produce world class MfEs. How to do it? Take 5 billion in stimulus money and offer it up to 50 colleges (the big dogs) who will develop named depts of MfE in chunks of 10,000,000 over 10 years. Soon we would be graduating MfEs that would lead America back to the top of world in manufacturing, the real wealth producing activity that made the US of A great.

Mfg is poised to be one of two things - either hinder the US from pulling out of the economy we are in now, or the opposite. Young people ought to get involved at the design level and be able to understand that they can drive the technology and innovation they want to purchase. The level of comfort we enjoy is propelled by their innovation, or lack thereof. If you can get young people to care about it, Mfg can move mountains. If you can't, then you are like every other industry trying to vie for their attention.

[Industry Comment] Sorry for the rant. My point (to bring this back to the original topic of manufacturing eduction) is that these realities need to be taught to our young, up-and-coming students and anyone in the manufacturing community who is seeking education. The longer we pretend these fatal flaws in American manufacturing and industry don't exist, the more and more fragile (and short-lived) America's economy will be.

The whole framework and context of manufacturing education needs to change dramatically concomitant with parallel changes in the views of both academia and society. The view must be embraced that all wealth and prosperity generation endeavors can be construed as 'Manufacturing' - these processes are generically common and should not be divided and distributed among different silo'd disciplines. Integration, project based learning, collaboration, teamwork, communication together with self-learning based on stimulated curiosity and the discovery by students of innovative solutions to ambiguous problems must become a focus. All engineering must be viewed as manufacturing and process sciences must receive greater emphasis alongside the management, business, economic and sustainability ramifications - all engineers must have awareness and competency to establish/appreciate new knowledge

and 'best practices' in all these areas. Project based collaborative learning must be encouraged from middle school through graduate education.

The ability of engineers involved in product realization (design & manufacturing) through post delivery support and disposal to work effectively in the contemporary and future workplace, they must be well equipped to work well in the global environment. This includes having a good foundation for working cross-culturally, communicating technically in the virtual environment, and executing projects extremely well. I would recommend that additional content in the area of project management also be considered.

Comments that deal with manufacturing and manufacturing education in general. These comments indicate issues with the perceptions and/or image of manufacturing education.

Our current government is doing little to assist manufacturing. Policies and regulations being proposed or implemented are often extreme, while in principle may be somewhat noble and PC, do nothing but provide incentives for companies to continue to move their mfg. to other countries.

Image: Not so long ago the image factor associated with manufacturing was that it was dark, dirty, dangerous, disorganized, etc. etc. Today, it is that the US manufacturing base is perceived to be disappearing. There are very few good news manufacturing stories on TV news or in the papers today, most are negative in some way. This makes it very difficult to recruit students into mfg. programs.

Regarding the first section of the survey: While the return to a manufacturing-based economy will be necessary for the US economy to recover and maintain growth, my primary fear on this front is that continued offshoring of manufactured goods will stifle and delay any sustainable growth in the US economy.

There is a negative social stigma to manufacturing. Although thousands of jobs have been lost in manufacturing, there are still thousands of jobs available. In my area of the country mfg has gone from 50% of the employment down to about 30%, creating one of the highest unemployment rates in the country. However, manufacturing is still the largest employer in this area! People are gun-shy. Parents are NOT encouraging their children to go into manufacturing. In the next decade, there will be a significant shortage of skilled manufacturing workers, and education needs to bite the bullet during these tough times, promote the successes of their manufacturing students/graduates, and prepare the workforce of the 2020s.

I do not see the image of the US Manufacturing changing any time soon as the media and what parents think has not favorable changed.

Manufacturing image will not get help from current policies unless manufacturing is tied to alternative energy since it is the focus of the current administration.

I am not sure what are you trying to get and justify by this survey. The Design/ Manufacturing in this country needs real attention, and nobody seems to care.

Obviously not everything will increase as answered above, but I do believe the amount/rate of change will continue to increase in most all the above topic areas.

I think the ability to specialize in the above topics is a way to focus on important items. In my opinion most of the above topics need more emphasis but it is not possible to teach/know everything.

I spent 20 years in Manufacturing before becoming tenured faculty. I'm not clear where manufacturing will go politically so made no assessment.

The low rankings on management topics are due to the disdain I have with ABET trashing the specific technical requirements for Manufacturing Engineering Technology, in favor of soft skills and basic credentials and the movement toward a NAIT model. If Manufacturing Engineering and Engineering Technology are trying to emulate business schools they will lose. We need to move, but it should be in a more technical way and not toward the business side. We need to differentiate manufacturing education.

[Industry Comment] A focus on the fundamentals is absolutely needed. Manufacturing needs an interested society and education system capable of producing contributors not just Engineers. I would take a non-degreed Manufacturing leader who understands the fundamentals vs. a degreed Engineer with very little hands on manufacturing knowledge. Media needs to connect with manufacturing outside of Mass Production. Manufacturing & Engineering are cool if the focus stays away from industries hell bent on mass production.

[Industry Comment] People need to be educated additionally as to how our state and federal government have overstepped their bounds many decades ago in artificially forcing all manner of business, industry, commerce and free trade, and thereby has directly impacted (to the negative) the overall good that manufacturing has been able to achieve for the general population of American citizens. Government is inherently self-serving, self-building and wasteful and has NO business sticking their hands into every detail and aspect of manufacturing and industry. To the degree they keep doing this (in fact, they are still increasing it) manufacturing in America will continue to suffer and will continue to move overseas.

[Industry Comment] As well, manufacturing education needs to paint a clear and accurate image of labor unions in this country today. While there was a time

early in America's industrial age where unions provided a needed service, protecting children and all workers from significant and wide-spread physical harm, today the labor union is organized crime. Plain and simple; lets call a spade a spade. Through coercion, fear, threat of violence (amongst other things), political infiltration, and a wide range of other subversive techniques, the unions breed mistrust and poor work ethic, they stifle productivity and creativity, and they generally flush profitability right down the toilet veritably handing America's manufacturing over to lower cost alternatives and then blaming greedy company executives as scapegoats while they themselves (the union) regularly exhibit greed and selfish practices that make all others pale in comparison. I'm sorry, but (for example) $35+ per hour with unbelievable benefits for general manufacturing jobs to push the start button on a couple machines every half hour and sit on their butt reading magazines and newspapers (instead of doing ANYthing productive) in between machine cycles is NOT GOOD for American manufacturing or America's economy.

Comments that deal with the survey in general follow. The comments point out the variation between different manufacturing education programs.

[Industry Comment] Obviously answers reflect opinions based on our programs and the perceptions of our strengths and weaknesses.

The answers to the above should vary widely depending on the program that one is referencing. Some programs are now entirely eLearning and others have none. Some programs are completely hands-on process-oriented and others are strictly simulation including all of the projects. Is there truly an average anymore?

Responses to survey items will probably vary based upon the level of implementation of these topics at the respective academic institutions. Some of us are a step or two ahead of the rest with respect to the addressing of advanced manufacturing technologies.

Probably the thing that has really changed in the past 15-20 years is the diversity among the programs and the increasing emphasis on niche specialization (a clear reflection of the industries that we serve). Any one institution can't do justice to your list. As a group, the programs can cover the waterfront.

Conclusions

The conclusions drawn from the survey results are listed below.

- The results are biased towards manufacturing educators perspectives.
- Educators feel as if they will have an impact on manufacturing and the economy.
- Educators are inconsistently receiving support or encouragement from outside the manufacturing community.
- There is demand for more content in manufacturing programs in ALL topical areas listed.
- future surveys examining topical content in manufacturing programs should ask for relative importance of topics.
- Education must be tied to the needs of manufacturers.
- There are issues with the perceptions and/or image of manufacturing education.
- There is a natural variation between manufacturing programs.

This survey is but one of many ongoing efforts to determine current attitudes and plotting a future in manufacturing education. It is clear from the results on the importance of education topics that there are many competing needs, all deemed important. No single program could cover all of these well. This suggests that we should begin to develop specialized programs that focus on threads. A following survey would be valuable to identify the fundamental emphases manufacturing programs. For example, what does a program with a processes focus look like, compared to a program with a design focus, or compared to a program with a production focus.

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