ASKING THE EMPLOYER ABOUT M&P:
IS MATERIALS AND PROCESSES EDUCATION STILL IMPORTANT?

Warren Ginn, FIDSA / Sharon Joines, Ph.D., IDSA
North Carolina State University
gwginn@ncsu.edu / Sharon_Joines@ncsu.edu

1. INTRODUCTION AND RATIONALE

Materials and manufacturing processes are critical subjects for an industrial designer. This is because the materials and the methods by which those materials are manipulated and assembled are the industrial designer's medium. The same way artists, sculptors and craftsmen must understand the paint, marble, glass, metal or wood that they use to create their work, so too must industrial designers understand how their ideas, concepts, forms and specifications are expressed 3-dimensionally in the context of mass-produced products. Therefore, teaching students about materials and manufacturing processes should be central to educating a well-rounded industrial designer and a key goal of any undergraduate industrial design program (Bjornlund, 2011).

While industrial designers use many of the same tools and share many of the same concerns as engineers, this necessity for materials and manufacturing education does not suggest that industrial designers should be educated to be mechanical or manufacturing engineers or serve an engineering function in the product development process:

> *"Industrial designers still lack the training of physics, chemistry, mechanics and mathematics that lie behind solid engineering principles. Designers do, however, have an obligation to understand materials and processes so that engineers can effectively implement their vision. Likewise, engineers don't always take into consideration the importance of form, human interaction, and ergonomics that industrial designers are naturally drawn to. This is where the two must come together to create solutions that are compelling, intuitive, reliable, ecologically smart, and designed for cost efficient manufacturing."*
>
> —Beyond Design (2011)

But, has the industrial design education community been successful in preparing young designers to met this obligation? With approximately 600 industrial design graduates entering the US workforce every year (Choi & Malassigné, 2013), this competitive employment environment demands that these young designers be as well-prepared as possible. Employers have specific expectations of industrial design graduates in terms of their understanding of materials and manufacturing methods, but unfortunately those expectations are not always met (Ginn, 2014).

When considering curriculum development for undergraduate education of industrial designers, natural extensions of this line of reason include a series of questions: Does a student graduating in the US or Canada with a BS or BA in Industrial Design posses adequate skills, knowledge and awareness of materials to be an effective and valuable member of a product development team? Is this knowledge of materials and manufacturing still relevant and valuable to the employer? To avoid this becoming strictly an academic exercise, our industry should have a method for collecting this feedback and, just as importantly, a method for addressing this deficiency if we find that there is still room for improvement.

This paper focuses on portion of the research conducted for a Master of Industrial Design Thesis Project focusing on the current state of materials and processes education in undergraduate industrial design programs in the US and Canada. It's objective is to investigate how educators might be assisted to improve outcomes for industrial design graduates and create more value for clients (students) and consumers (employers). An additional goal is to develop a set of research-driven "best practices" for materials and processes education as well as a collection of teaching tools for educators. The research included a series of surveys to collect the perspectives, experiences and opinions from industrial design educators, recent graduates, current students and employers.

2. PREVIOUS WORK

Two seminal research works focusing on contemporary design education are reviewed below. Through reaching out to the professional and academic community, each study paints a picture of the current state (at the time) of design education for their discipline and its relevance and connection to professional practice.

2.1 BOYER REPORT ON ARCHITECTURE EDUCATION (1996)

Because of the critical role materials and building technologies play in the health, safety, welfare and comfort of its users, the architecture education community has standards established by their accrediting body, the National Architectural Accrediting Board, Inc. (NAAB). Established at about the same time as the National Association of Schools of Art and Design (NASAD) and similar to its accreditation standards for industrial design programs, NAAB seeks to evaluate education 'outcomes'—entry-level qualifications for a graduating architecture student—while not specifically telling schools how to teach (prescribing curricula).

While NAAB offers a similar level of detail provided by NASAD, the architecture education community agrees there should be 'standards without standardization.' As part of its "tradition of self-examination," Boyer & Mitgag, (authors of Building Community: A New Future For Architecture Education and Practice : A Special Report (also referred to as "The Boyer Report"), published the results of a study conducted in 1994 intended to examine the current state (in 1994) of architecture education. Boyer & Mitgag, surveyed students, faculty and alumni of fifteen accredited U.S. schools of architecture as well as the deans and department heads at all professional architecture programs in the United States at that time. They also visited with two dozen architectural firms to discuss the realities of practice, the challenges ahead for the profession and their thoughts about the education or architects. From their surveys and research, Boyer & Mitgag identify successes, challenges and opportunities for improvement. There are several parallels to be drawn with regards to architecture education and the requisite material and technical training (e.g., materials and structures) and the education of industrial designers and materials and manufacturing education.

First, Boyer & Mitgag point out that while schools of architecture should recognize the core of any program is 'design,' there is a necessity for the other aspects of the profession: management and technical mastery. Materials and structures (the technical aspects of architecture) is highlighted as a critical part of the education of an effective architect.

Second, Boyer & Mitgag's research revealed that there was a "[a] lack of integration of technical and practical knowledge into design work is probably the single most widespread area of program weakness." In response, the authors call for "A Connected Curriculum" that recognizes the "essential interdisciplinary nature of architectural decision making" (Boyer & Mitgag, 1996).

> *"A good architect is someone capable of seeing the main problems of a design, capable of examining with serenity the various possible solutions, and who has a thorough grasp of the technical means necessary to accomplish his project."*
>
> —Pier Luigi Nervi

There are many useful lessons to be learned from the Boyer Report. It outlines a process by which the education community can reach out to professionals to get specific feedback on how successfully they have prepared architecture students for professional practice. More importantly, it takes that feedback and synthesizes it into specific, actionable recommendations for the educators and administrators going forward. This report serves as a useful guideline for how the industrial design education community might conduct a similar comprehensive study leading to similar thoughtful recommendations for improvement.

2.2 LIU EDUCATION SURVEY (2005)

Tsai Lu Liu's "The Focus of Industrial Design Education: Perspectives from the Industry" (Liu, 2005) sought to provide feedback from the perspective of the design industry in terms of how successful the efforts of the industrial design education community have been in the preparation of industrial design students for professional

practice. An email survey was distributed to 1,343 designers, managers and executives working for both design consulting firms and manufacturers with 125 (9.3%) responses. In addition to demographic and industry information, the survey asked participants about their experiences hiring new industrial designers and to rank the importance of the necessary skills of an industrial designer. In addition, the survey asked the participants to indicate their opinions concerning the abilities of recent Industrial Design graduates (within the past 5 years) with regards to a list of specific skills like innovation, sketching, styling, ergonomics, knowledge of materials, production processes and technical engineering. The results demonstrated that problem solving, innovation and sketching were the top three most requested skills. Knowledge of materials ranked 8 out of 14 skills listed in the survey. Results also indicated that the areas of materials knowledge, technical engineering, and marketing needed improvement.

This survey generated a very useful snapshot for the current state (in 2005) of industrial design education, creating a valuable feedback loop for educators. While the survey was well-constructed to generate quantitative data from closed-ended questions, there were no opportunities for participants to add their own thoughts or comments through open-ended questions (other than the "other" option for some questions). Collecting qualitative data would be valuable for adding additional depth and context to the feedback provided through such survey tools. Combining both closed-ended and open-ended questions might paint a more complete picture and yield additional, unexpected insights; this refinement in the survey data collection approach informed the methods used in the current investigation.

3. METHODS OF STUDY

A survey was constructed and distributed using an online survey tool (Qualtrics) to reach out to businesses in the US and Canada that employ industrial designers. Email requests for participation were sent to 728 professionals representing all areas of industrial design including product development consultancies ("design firms"), original equipment manufacturers ("OEMs") and suppliers (e.g., contract molders, material suppliers, etc.). A wide range of markets (consumer, industrial, medical, etc.) and company sizes were represented. The list of email recipients was generated from a combination of those listed as "head of office" in the Industrial Designers Society of America (IDSA) online Membership Database and the author's additional professional contacts within the industry (those who were heads of office or managers responsible for interviewing and/or hiring industrial designers).

3.1 SURVEY STRUCTURE AND QUESTIONS

The survey consisted of 34 questions that can be grouped in two halves. The first half of the survey (16 questions, 47%) covered the Informed Consent as well as demographic information about the participant (gender, age), their education (year, degree and institution) and their organization (size, type, market, number of employees and industrial designers, etc.). Differentiating between product development consultancies ("design firms") versus in-house design offices was important in determining if materials and manufacturing knowledge was particularly more important or useful to manufacturers with industry-specific needs (e.g., a specific type of material like HDPE or manufacturing process like thermoplastic injection molding) as opposed to those required by a consultancy which may be involved in projects covering a wider range of materials and/or manufacturing processes.

The second half of the survey (questions 17-34) addressed the role industrial designers play within their organization, the importance of materials and manufacturing processes (M&P) expertise in their work and how that effects their hiring practices. Participants were asked questions regarding their expectations of industrial designers (particularly recently graduated, entry-level industrial designers) and their findings when interviewing candidates. They were asked to rank a list of 15 skills in order of importance to the employer:

- 2D Digital Skills (Illustrator, Photoshop)
- CAD / 3D Modeling
- Human Factors
- Innovation / Imagination
- Manufacturing / Production
- Marketing and Branding
- Materials / Color and Finish
- Physical Model Making
- Product Rendering
- Sketching and Visualization
- Styling / Form Development
- Teamwork / Collaboration
- Technical Problem Solving / Engineering
- User Research
- Verbal Communication

In addition to the closed-ended questions, participants were given the opportunity to share their thoughts or comments through open-ended questions. The first, Question 20, asked what the minimum level of knowledge of M&P is expected of entry-level industrial designers and what does the employer want them to know and

understand. It asked the participant to describe what was important to them as employers. The second open-ended question and the last in the survey, Question 34, asked for any thoughts, comments ideas and/or suggestions that might be helpful for the study and/or might help educators improve learning outcomes.

The two open-ended questions were separated by a series of closed-ended questions intended to identify the participants' opinions regarding the role a recently graduated, entry-level industrial designer's level of M&P knowledge played in an employer's hiring decisions. Participants were also asked to assess the typical level of M&P knowledge demonstrated by candidates in an attempt to measure the degree of success in M&P education.

3.2 PARTICIPANTS

Data for the survey of US and Canada businesses employing Industrial Designers was collected between Dec 1, 2013 to Feb 17, 2014. Of the 728 contacted, 88 responses (12% participation rate) were received with a mix of both product development consultancies and OEMs (see Figure 1). Most participants were male (93%) with design degrees (over 95%); 30% also had advanced degrees.

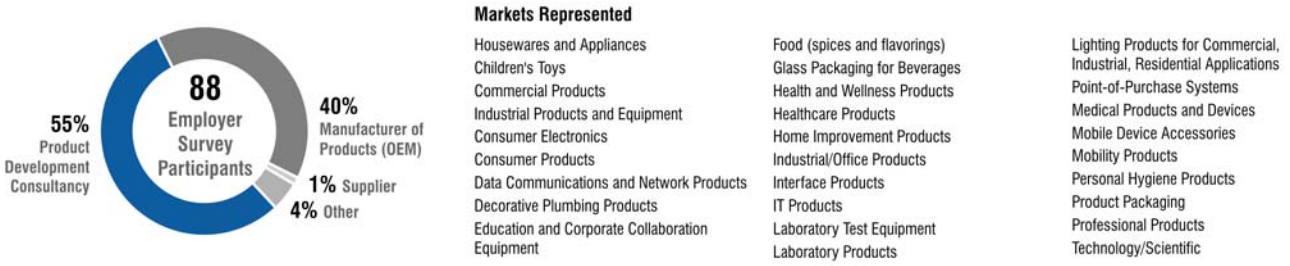

Figure 1. Employer survey participants and markets represented (n = 88).

Though the return rate was 12%, we suggest that those who responded felt strongly about the subject of materials and processes (which was in the title of the survey). However, this does not necessarily indicate any specific bias for or against the subject, only that they considered it to be an important subject and worth their time to express their opinions. Below is an overview of the results and how interpretation and insights can be enhanced through synthesis with the open-ended written responses from the participants.

4. RESULTS OF SURVEY

Similar to the Liu survey (Liu, 2005), participants were asked to rank 15 skills in order of importance to the employer. The rankings are shown in Table 1 with green indicating the strength of the response for a specific ranking. For example, most participants ranked "Innovation / Imagination" as most important (#1), followed by "Sketching and Visualization", etc. While it consistently ranks higher than other traditional Industrial Design skills like "Marketing and Branding" and "Physical Model Making", "Materials, Color and Finish" and "Manufacturing / Production" are ranked in the lower half to the lower third of the list.

Table 1. Skills Ranking (%) for All Participants (n = 88).

Skills Ranking: All Employer Participants		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Innovation / Imagination	0.57	0.14	0.09	0.05	0.05	0.05	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.00	0.00
2	Sketching and Visualization	0.11	0.23	0.10	0.15	0.09	0.10	0.10	0.01	0.01	0.02	0.00	0.02	0.05	0.00	0.00
3	Teamwork / Collaboration	0.11	0.16	0.13	0.15	0.09	0.02	0.08	0.06	0.08	0.03	0.03	0.00	0.02	0.03	0.00
4	Styling / Form Development	0.05	0.13	0.14	0.19	0.08	0.09	0.03	0.03	0.08	0.06	0.05	0.02	0.00	0.03	0.02
5	User Research	0.01	0.08	0.09	0.03	0.06	0.07	0.14	0.10	0.08	0.07	0.07	0.10	0.05	0.02	0.03
6	Verbal Communication	0.03	0.11	0.06	0.06	0.11	0.07	0.08	0.07	0.06	0.05	0.03	0.05	0.07	0.08	0.08
7	CAD / 3D Modeling	0.03	0.03	0.10	0.08	0.17	0.10	0.07	0.05	0.06	0.07	0.10	0.05	0.05	0.03	0.01
8	Human Factors	0.05	0.03	0.06	0.08	0.09	0.06	0.07	0.15	0.08	0.10	0.06	0.07	0.08	0.02	0.01
9	Technical Problem Solving / Engineering	0.00	0.05	0.08	0.09	0.05	0.15	0.06	0.13	0.09	0.13	0.06	0.07	0.05	0.02	0.00
10	Materials / Color and Finish	0.00	0.00	0.02	0.01	0.02	0.06	0.05	0.15	0.10	0.11	0.17	0.11	0.09	0.06	0.05
11	Product Rendering	0.02	0.02	0.03	0.03	0.06	0.08	0.08	0.07	0.10	0.08	0.07	0.09	0.16	0.05	0.06
12	Manufacturing / Production	0.00	0.00	0.02	0.01	0.03	0.06	0.09	0.03	0.05	0.13	0.14	0.14	0.08	0.14	0.09
13	2D Digital Skills (Illustrator, Photoshop)	0.00	0.01	0.07	0.03	0.06	0.07	0.09	0.03	0.05	0.07	0.13	0.09	0.09	0.09	0.13
14	Marketing and Branding	0.01	0.01	0.01	0.03	0.02	0.02	0.03	0.03	0.10	0.05	0.07	0.10	0.09	0.19	0.22
15	Physical Model Making	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.08	0.06	0.02	0.03	0.09	0.13	0.23	0.31

4.1 Comparison of Closed and Open Ended Responses

While the skills ranking above might suggest that materials and manufacturing knowledge is not that important, the other responses from the participants paint a different picture. When asked,

> *"How important is it for an entry-level industrial designer to have a solid knowledge of materials and manufacturing?"*

The majority of the participants responded to the prompt rating knowledge of materials and manufacturing as either extremely important or quite important (see Figure 2). This contrasts with the ranking of materials and processes in the lower third of the skills.

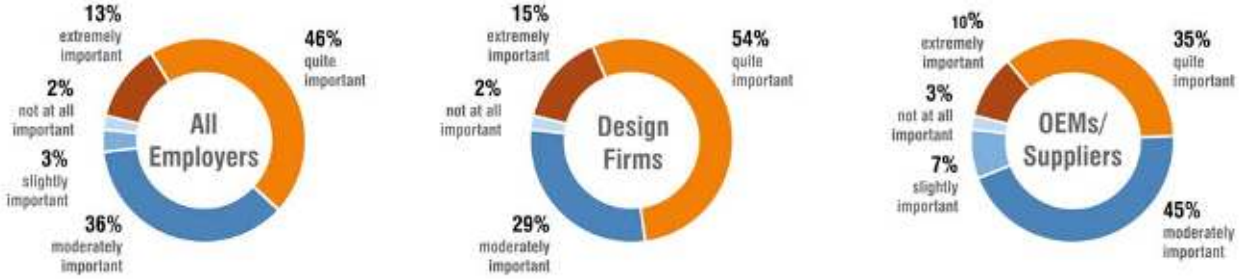

Figure 2. Response to "How important is it for an entry-level industrial designer to have a solid knowledge of materials and manufacturing?"

To make more sense of this apparent disparity, several other data points were assessed together to more accurately gauge the opinions of the employer participants. First, participants were asked two open-ended questions that allowed them to express (in their own words) what they felt was important to them in terms of the expected level of materials and manufacturing knowledge an entry-level Industrial Designer should have and their thoughts and feedback on how and what students are taught in terms of materials and manufacturing. The two prompts were:

> *"Please describe what minimum level of knowledge of materials and manufacturing is expected of entry-level industrial designers. What do you want your entry-level designers to know and understand? What's important to you as an employer?"*

> *"If you have any thoughts, comments, ideas and/or suggestions that might be helpful for this Study, please enter them below. How might educators improve?"*

Responses (Table 2, columns A and B) ranged from a few words or phrases to long, multi-paragraph, detailed discussions of their views on the subject. Over 77% wrote more than one sentence and over 63% wrote in both text boxes indicating that they had a lot to say on the subject.

The written responses collected from these questions were scored from 0 to 5 rating how strongly ("emphatic") the participant expressed their opinions (Table 2, column D). A rating of 5 would indicate that the participant was expecting a significant degree of M&P knowledge from the entry-level ID. A rating of 0 indicates that an entry-level ID wasn't expected to know much, if anything about the subject (e.g., they would just learn on the job). For some participants, this sentiment was expressed within their response to the first question above, whereas others expressed themselves more completely responding to the second. Considering the qualitative responses for both questions together yielded a more complete understanding of the participant's opinion.

These ratings were compared to the participant's response to the question above regarding the importance of an entry-level industrial designer having a solid knowledge of materials and processes (Table 2, column E). If the written comments in the open-ended questions were consistent with their response in the closed-ended question, the participant was scored (Table 2, column F) with a "Yes." If the comments and response did not agree (e.g., the participant states that the employee doesn't get hired without materials and processes knowledge, but responds to the "importance" question with only "slightly important") then the participant would be scored with a

"No." Eighteen of the participants (20%) either did not agree or could not be scored, because they did not enter any text for either of the open-ended questions.

The second step of this analysis was to review the individual rankings each participant gave to the skills "Materials / Color and Finish" and "Manufacturing / Production" (Table 2, columns G and H). Since materials and manufacturing processes are typically taught together, it was reasonable to consider that some participants might choose one of these over the other even though they closely relate. While some participants ranked one or the other towards the bottom of the list, 73% of the participants ranked at least one in the "top 10." If they did rank either in the top 10, they were considered to view materials and manufacturing knowledge as a favorable and valuable skill (Table 2, column J).

These two analyses of the open-ended responses and the skills rankings allowed 2 points of potential agreement:

- Do the comments supplied by the participant agree with their statement regarding the importance of an entry-level industrial designer having a solid knowledge of materials and processes?
- Does that agreement match with the participant's assigned ranking of 10 or higher to either "Materials / Color and Finish" or "Manufacturing / Production?"

Table 2. Illustration of data evaluation method between the participant's written comments (with ranking).

A	B	C	D	E	F	G	H	J	K
Type of organization.	Minimum level of knowledge expected of entry-level industrial designers. What's important to you as an employer?	Have any thoughts, comments, ideas and/or suggestions? How might educators improve?	How emphatic is the participant that entry-level IDs understand M&P? (0-5, 5 being highest)	How important is it for an entry-level industrial designer to have a solid knowledge of materials and manufacturing?	Do the comments and level of importance agree?	Ranking for Materials / Color and Finish	Ranking for Manufacturing / Production	Either ranking higher than 10?	Do the comments and rank agree?
Product Development Consultancy		If they don't have a baseline knowledge of M&P, they don't get hired.	5	Quite important	Yes	7	12	Yes	Yes
Manufacturer of Products (OEM)	I expect at least a high level awareness of commonly used processes in manufacturing and the implications that these processes have on designs.	I feel the most important value of designers understanding materials and process is for designers to have an understanding of the relationship between design decisions and materials and processes.	5	Moderately important	Yes	11	14	No	No
Product Development Consultancy	Understand basic manufacturing techniques from: Vacuum forming, to basic injection molding, extrusions, castings, sheet metal bending, rapid prototyping, machining. They also need to have a basic understanding of what materials are used in current product design manufacturing.	I think that whenever I see products that stands out, it is most often because there is a novel aspect about a finish or a new manufacturing technique.	5	Moderately important	Yes	12	14	No	No
Product Development Consultancy	It's important because we design product that go to market (no concepts) and they need to be design to meet many different constraints.		4	Moderately important	Yes	6	7	Yes	Yes
Manufacturer of Products (OEM)	Foundational knowledge of manufacturing materials and processes(injection molding, metal casting, etc). Most is learned on the job specific to our needs.	Aside from classes in concept development, having a manufacturing concept should be part of every final product design concept.	3	Moderately important	Yes	10	14	Yes	Yes
Product Development Consultancy	Having a basic understanding of what processes are available, how they are implemented and when they should be used is very desirable.		2	Quite important	No	11	15	No	Yes
Manufacturer of Products (OEM)	It would be nice if entry level designers have a fundamental understanding of injection molding		2	Moderately important	Yes	8	7	Yes	Yes
Product Development Consultancy	We expect common sense knowledge, and a willingness to learn.		1	Not at all important	Yes	10	13	Yes	Yes
Other (Design Research)	None. They need to know how to do design research.		0	Not at all important	Yes	9	14	Yes	Yes

The data presented in Table 2 express how important participants think entry-level it is that industrial designers have a solid knowledge of materials and processes and the rank they assigned to the skills "Materials / Color and Finish" and "Manufacturing / Production." The last column on the right (Table 2, column K) indicates the agreement between an individual's expressed opinions. Most (67%) of the respondents were consistent (showed agreement) between their written comments, selected level of "importance" and skill ranking data. A significant number (73%) of all respondents ranked either "Materials / Color and Finish" and "Manufacturing / Production" in the top 10 and when removing those respondents, where their comments and rankings were not in agreement each other, that number rose to 88% ranked either "Materials / Color and Finish" and "Manufacturing / Production" in the top 10. While not necessarily considered to be the most critical skill for an industrial designer, a working knowledge of materials and manufacturing process is clearly very important to the employer and a critical skill (see Figure 3).

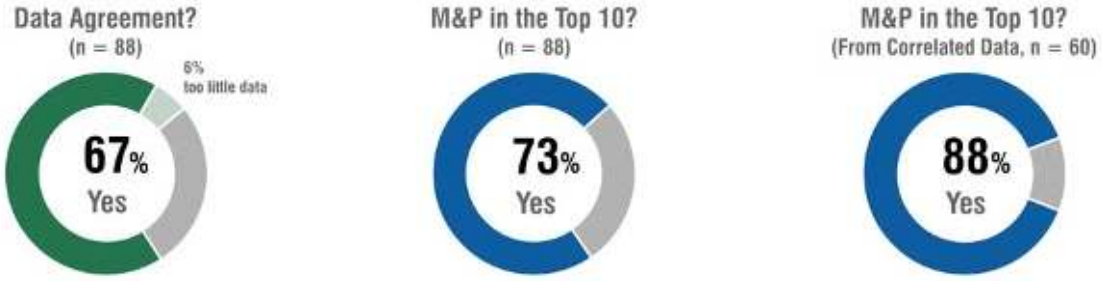

Figure 3. Results of data agreement analysis.

4.2 ADDITIONAL BENEFITS OF OPEN-ENDED SURVEY QUESTIONS

In addition to providing the ability to cross-check participant responses, these written statements provided information and insights into what, specifically, the employers are looking for and think is important. From the text from both open-ended questions, a ranking was generated for the words and phrases most frequently used. A word cloud representation of that data is presented in Figure 4. Not surprisingly, "plastic injection molding" was the most commonly requested process that employers wanted entry-level industrial designers to be familiar with. But traditional processes like "sheet metal bending, forming and fabrication" and "machining" were also in the top 5. From this list of words and phrases, culled directly from the employer written responses, a working set of learning outcomes can be developed into the foundation of a materials and processes curriculum.

Figure 4. Word cloud of materials and processes employers want entry-level industrial designers to know based on responses to open-ended survey questions.

4.3 LIMITATIONS OF THE SURVEY

Surveys are imperfect tools. The accuracy and validity of the data collected is subject to many variables, starting with the construction of the survey itself. The questions, their wording and the length of the survey can lead to erroneous or misleading conclusions. The questions outlined above are intended to capture the participant's thoughts and opinions without influence. The available options within a specific question might inadvertently skew the data, so to address this potential risk, many questions offered participants with a "none" or "neither" option. For more complex questions, an "other" selection with an associated text box allowed them to enter their own option. In addition to the "other" option text boxes, two questions (described above) offered the participants to express their thoughts and opinions in their own words. An additional benefit of these open-ended "in your own words" text boxes is that they can be used to evaluate the selections for the closed-ended questions. In a case where the participant accidently selected an answer they didn't intend to select, the written text responses might reveal an inconsistency or lead to deeper insights regarding that conflict. Conversely, text responses can reinforce responses, particularly where the participant felt strongly.

5. CONCLUSION

Taken at face value survey data with solely quantitative data may be misleading. While messy and hard to efficiently manage, open-ended, qualitative data can provide a deeper understanding of the issues at hand. This can resolve ambiguity and add clarity to the findings. If someone were to look at the skills ranking alone, without context, one might conclude that spending time and resources to educate industrial design students about material and manufacturing processes was not a wise investment. But by digging deeper and "connecting the dots" between the quantitative data from the closed-ended questions and the rich qualitative data from the open-ended questions, it is clear that the study of materials and manufacturing remains a critical and valuable skill for industrial design students. Employers are expecting industrial design graduates to have this basic knowledge of how their product concepts can be manufactured and the materials that will be employed.

Using surveys as a feedback loop between educators and stakeholders (e.g., students, graduate and employers) can be an effective method for curriculum evaluation and improvement. However, the construction of the survey can directly impact the conclusions derived from it. Providing open-ended questions with text boxes give the participant the opportunity to "fill in the gaps" and provide clarity for the closed-ended questions.

This paper is the first in a series of papers that will be published on the study of materials and processes education for industrial designers. These papers will focus on the results from the surveys of industrial design educators, students and graduates as well as the development and proposal for a baseline of "best practices" for teaching the subject. Tools and resources for the industrial design educator will also be proposed.

REFERENCES

Beyond Design. (2011). " Industrial Design Meets Engineering." In Whiteboard blog posted July 21, 2011. Retrieved on October 13, 2013 from http://www.beyonddesignchicago.com/whiteboard/2011/07/21/industrial-design-meets-engineering/.

Bjornlund, L. (2011). "Preparing for the Real World." Innovation (Spring 2011), 30(1), 51–55.

Boyer, E. L., & Mitgang, L. D. (1996). Building Community: A New Future For Architecture Education and Practice : A Special Report. Princeton, N.J.: Carnegie Foundation for the Advancement of Teaching, 63-90.

Choi, S., & Malassigné, P. (2013). "2013 Education Survey." Presented at the 2013 IDSA Education Symposium, Chicago, Il.

Ginn, W. (2014). "Materials and Processes Education in an Undergraduate Industrial Design Curriculum." Master of Industrial Design Thesis Project, NC State College of Design, Raleigh, NC.

Liu, T. L. (2005). "The Focus of Industrial Design Education: Perspectives from the Industry." Presented at the 2005 IDSA Education Symposium, Austin, Texas.