

# **Analysis of Soft Skills Requirements for Manufacturing Jobs**

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## **Abstract**

Soft skills, also known as professional skills, are as important as technical skills. The ability to solve problems, use one's time efficiently, and communicate with and lead others are essential skills in any job setting. This study analyzes soft skills in the manufacturing industry and identifies which skills manufacturing companies desire in prospective employees. No universal list of specific soft skills exists. This study identified and focused on ten skills and their appearances in 501 U.S. manufacturing job listings. Several prominent job search websites were used to collect data on soft skills, for both higher and lower-level manufacturing positions. Data relating to the number of soft skills and level of education desired by U.S. manufacturing companies was also collected and analyzed. Results show that the top soft skills required by manufacturing companies are problem solving, communication, and teamwork. The study also discusses the integration of soft skills into manufacturing simulation hands-on activities.

## **Keywords**

Soft skills, professional skills, manufacturing education, manufacturing simulation.

## **1. Background**

Current estimates show a shortage of roughly two million manufacturing jobs in the United States by the year 2025 (Giffi et al., 2015). Moreover, the mixed skill positions (those requiring both technical and non-technical skills) are rising in popularity (Lewis et al., 2008). Programs must produce candidates qualified for these positions, but many continue to focus heavily on the technical, and neglect non-technical skills development, despite the fact that non-technical skills are predictive of success in both life and the workplace (Schutt et al., 2017). Surveys of industry confirm this, reporting that non-technical, also known as professional or soft skills, are needed but lacking (Barger et al., 2008).

Previous surveys indicate that soft skills are more important during the job interview process than academic or technical skills (Proctor, 2016). The technical and academic skills shown on a resume rarely show the applicant's aptitude in the soft skills discussed in this research. One's ability to perform essential daily functions like communicating with superiors, co-workers, and customers cannot be seen by potential employers on paper, thus making soft skills used during the interview process and after an employee is hired all the more important.

"Soft skills" is an umbrella term covering non-technical skills (e.g. effective communication, leadership) and personality traits (e.g. flexibility, professionalism). While multiple studies address the importance of soft skills in the workplace and note that formal education frequently does not provide them, there does not seem to be a consensus on which skills should be examined. A report by the Office of Disability Employment Policy (ODEP) of the U.S. Department of Labor discusses a way to introduce teamwork, problem solving, critical thinking, and communication in the classroom (ODEP, 2010). Barger et al. (2008) have created a simulation game teaching listening, teamwork,

leadership, flexibility, and communication. Garcia-Reyes and de la Garza (2015) proposed teamwork, communication, and self-motivation can be learned by reshaping a class through problem based learning. Other literature on the matter is similarly diverse.

While there is some overlap – teamwork and communication are common – in previous studies, there is insufficient agreement about what soft skills the workforce should be trained in, especially for careers in manufacturing. To resolve this, online job advertisements in the United States were surveyed, and the soft skill qualifications were recorded in this paper. Ten skills were found with varying frequency in the postings: accountability, communication, ethics, flexibility, leadership, multitasking, organization, problem solving, professionalism, and teamwork.

## 2. Research Methodology

The proposed research methodology is presented in Figure 1. First, we defined the goals of our study which include identifying soft skills requirements for manufacturing jobs and integrating these skills into manufacturing simulations. Then we developed a search strategy to extract the data for the soft skills requirements. Manufacturing job postings were located through online career search engines, which broadcast open positions to a wide audience to attract qualified candidates. Since this research concerns the projected skills gap related worker shortage, this recruitment medium reflected our expectations. Popular sites such as glassdoor.com, indeed.com, monster.com, snagajob.com, and ziprecruiter.com were used alongside the field specific engineerjobs.com and the Pennsylvania State University’s in-house NittanyLion Career Network. To pare the listings to manufacturing specific jobs, the key words “manufacturing,” “machine operator,” “manufacturing technician,” and “manufacturing engineering” were used. Listings from prior to 2018 were discarded to ensure current data, though the existence of older postings is further evidence of the need for qualified manufacturing professionals.

Each posting was verified to be a manufacturing position – sales and customer service positions for manufacturing companies were excluded, as well as one “production technician” for a television station – and the details were placed in a spreadsheet. Job title, company, location, source (website), salary, minimum experience, education, and soft skills were recorded as available.

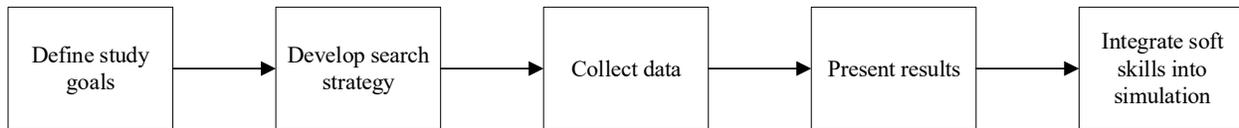


Figure 1. Proposed research methodology

When analyzing the job listings, the researchers did not look solely for concrete listings of the specific soft skills. Sections within the job listings (job description, responsibilities, qualifications, essential functions, performance, experience, skills, etc.) were read thoroughly and some inferences were made to connect a responsibility or performance expectation and one of the ten soft skills being studied. For instance, “*Ability to perform multiple tasks concurrently in a fast-paced environment*” was recorded as a desire for the soft skill of Multitasking/Time Management; “*Must be able to report effectively using both verbal and written methods*” was recorded as a desire for the soft skill of Communication; and “*Define actions to increase productivity through the management of people*” was recorded as a desire for the soft skill of Leadership. The specific soft skills were recorded in the following ten areas: (1) Leadership, (2) Problem Solving, (3) Multitasking, (4) Communication, (5) Teamwork, (6) Organization, (7) Professionalism, (8) Ethics, (9) Accountability, and (10) Flexibility. Mentions of critical thinking were grouped with problem solving, time management with multitasking, and adaptability with flexibility.

## 3. Data Collection and Analysis

The data showed a clear desire for the various soft skills discussed in all levels of the manufacturing industry, with a strong preference on three soft skills: Teamwork, Communication, and Problem Solving/Thinking Critically. Figure 2 shows the frequency of the ten soft skills as they were mentioned in all 501 manufacturing job listings.

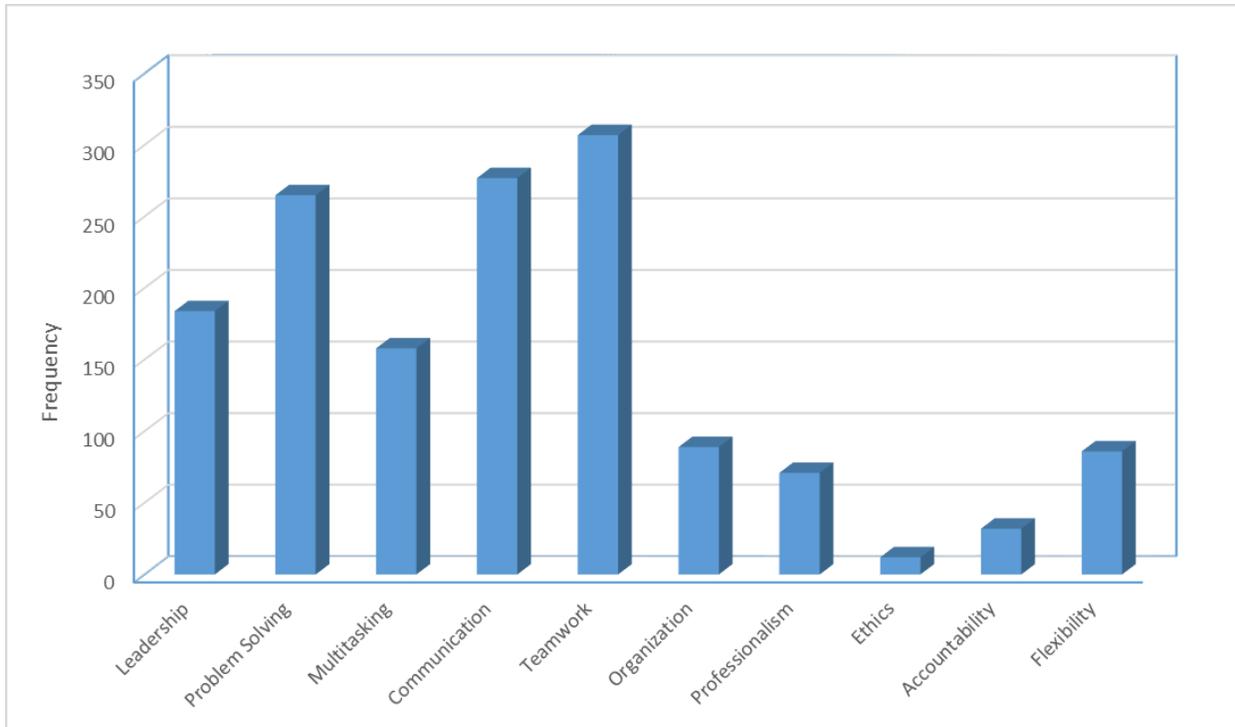


Figure 2. Soft skill frequency across manufacturing job listings

A distinction can be made between the three most desired soft skills (Teamwork, Communication, and Problem Solving/Thinking Critically) and the remaining seven skills as they were mentioned in over 50% of the 501 job listings. Not far behind were Leadership and Time Management skills at 36.73% and 31.54%, respectively.

When the job postings are analyzed and separated by education requirement, differences in soft skill requirements are seen. For jobs requiring at least a bachelor's degree, the most common soft skills requirements are problem solving (65% of all postings), teamwork (64%), communication (60%), leadership (53%), and multitasking (33%), as shown in Table 1 which shows the analysis of BS+ jobs postings. The total number of job postings is 318.

Table 1. Soft skills in positions requiring at least a bachelor's degree

Skill	Frequency	Percentage
Leadership	168	52.83%
Problem Solving	208	65.41%
Multitasking	104	32.70%
Communication	192	60.38%
Teamwork	202	63.52%
Organization	64	20.13%
Professionalism	27	8.49%
Ethics	11	3.46%
Accountability	16	5.03%
Flexibility	32	10.06%

However, Table 2 shows key differences in soft skill requirements for jobs with a lower education requirement (i.e., Associate -, with 183 job postings). Teamwork (58%), communication (47%), and multitasking (30%) remain important, but leadership all but disappears (8%). Problem solving is still important as it appears in 31% of job

listings, but is less critical than in bachelor’s level positions. Flexibility, however, appears three times as frequently (30% of postings) than in the positions requiring higher education (10%). This means that different soft skills should be developed at different education levels. While problem solving, multitasking, communication, and teamwork should be included in curricula at all levels, high school, vocational, and certificate programs should include flexibility, while university programs should include leadership and even more problem solving.

Table 2. Soft skills in positions requiring an associate degree or less

Skill	Frequency	Percentage
Leadership	15	8.20%
Problem Solving	57	31.15%
Multitasking	54	29.51%
Communication	86	46.99%
Teamwork	107	58.47%
Organization	25	13.66%
Professionalism	31	16.94%
Ethics	1	0.55%
Accountability	16	8.74%
Flexibility	54	29.51%

The total number of soft skills mentioned in each of the 501 job listings is displayed in Figure 3. The majority (65.87%) of the 501 job listings mentioned either two, three, or four of the ten soft skills recorded, while only 18.16% of the job listings mentioned either zero (3.79%) or one (14.37%) soft skill. The remaining number of soft skills mentioned (five, six, or seven) occurred in 15.97% of the 501 job listings.

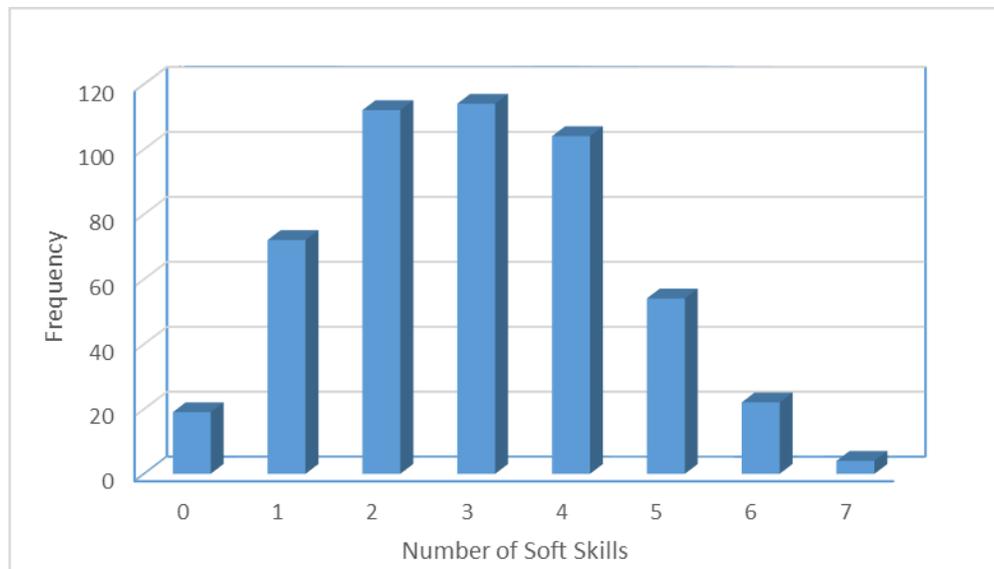


Figure 3. Number of soft skills per listing for all jobs

As with the specific skills, there is a difference between the 3.25 soft skills listed on average for a job requiring at least a bachelor’s degree, and the 2.46 average for jobs requiring no more than an associate degree ( $p= 0.000$ ). The statistical analysis of this difference is shown in Table 3, and histograms of the individual requirements in Figures 4 and 5. The results indicate that the number of manufacturing jobs that require bachelor’s degrees (and higher) is statistically higher than the number jobs that require associate degrees (or lower).

Table 3. Statistical analysis of soft skill requirements across education levels

	Sample Size	Mean	Standard Deviation
Bachelor's +	318	3.25	1.506
Associate -	183	2.46	1.372
P-value		0.00	0.16

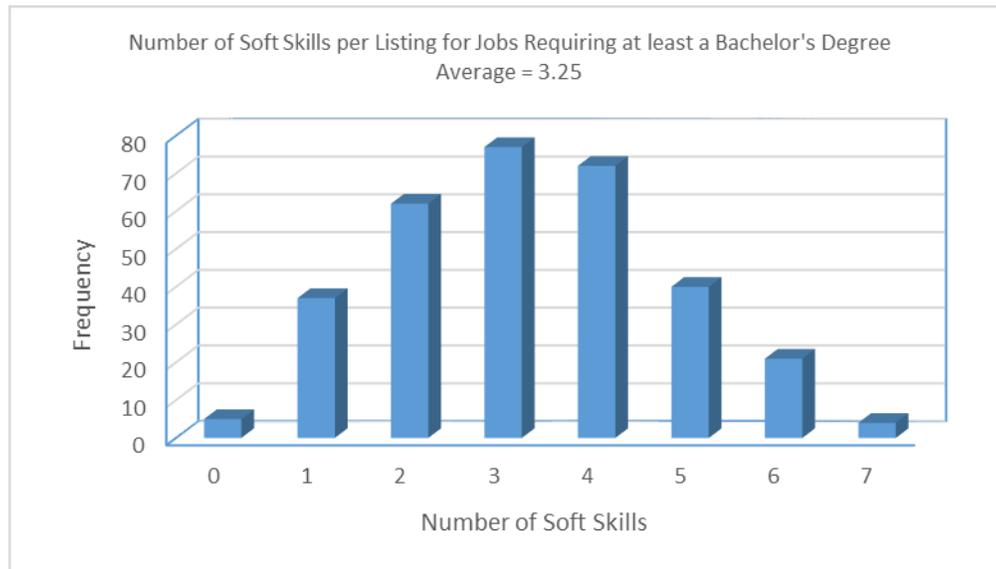


Figure 4. Number of soft skills per job with higher education

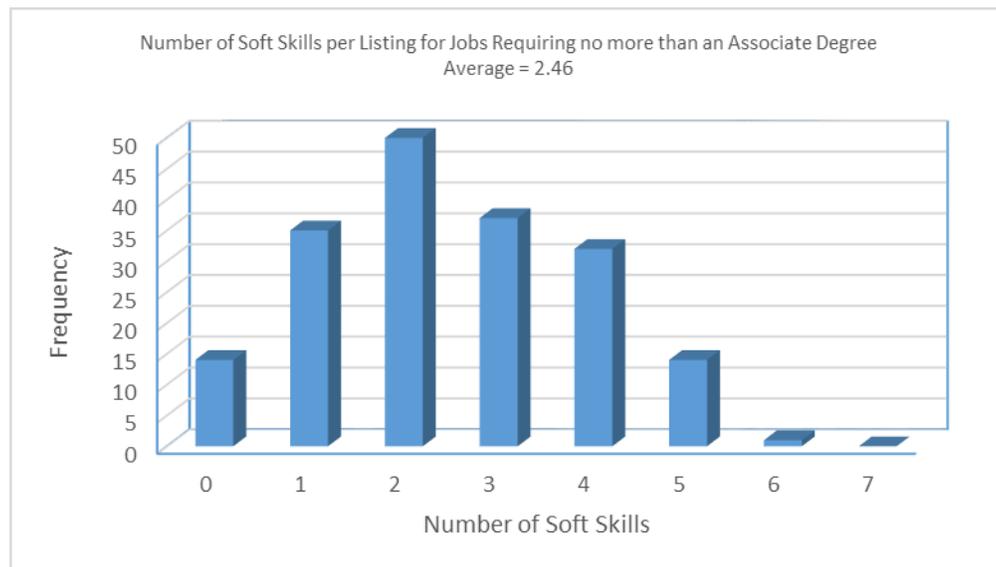


Figure 5. Number of soft skills per job without higher education

#### **4. Case Study: Integrating Soft Skills into Manufacturing Simulation**

In this section, we present the integration of some soft skills into a manufacturing simulation game. Mainly, we measured leadership and teamwork skills among the team members. The manufacturing game uses Lego blocks where team members work in groups to produce Lego cars. Some pictures of the manufacturing simulations hands-on activities are shown in Figure 6. Multiple soft skills workshops were also introduced.

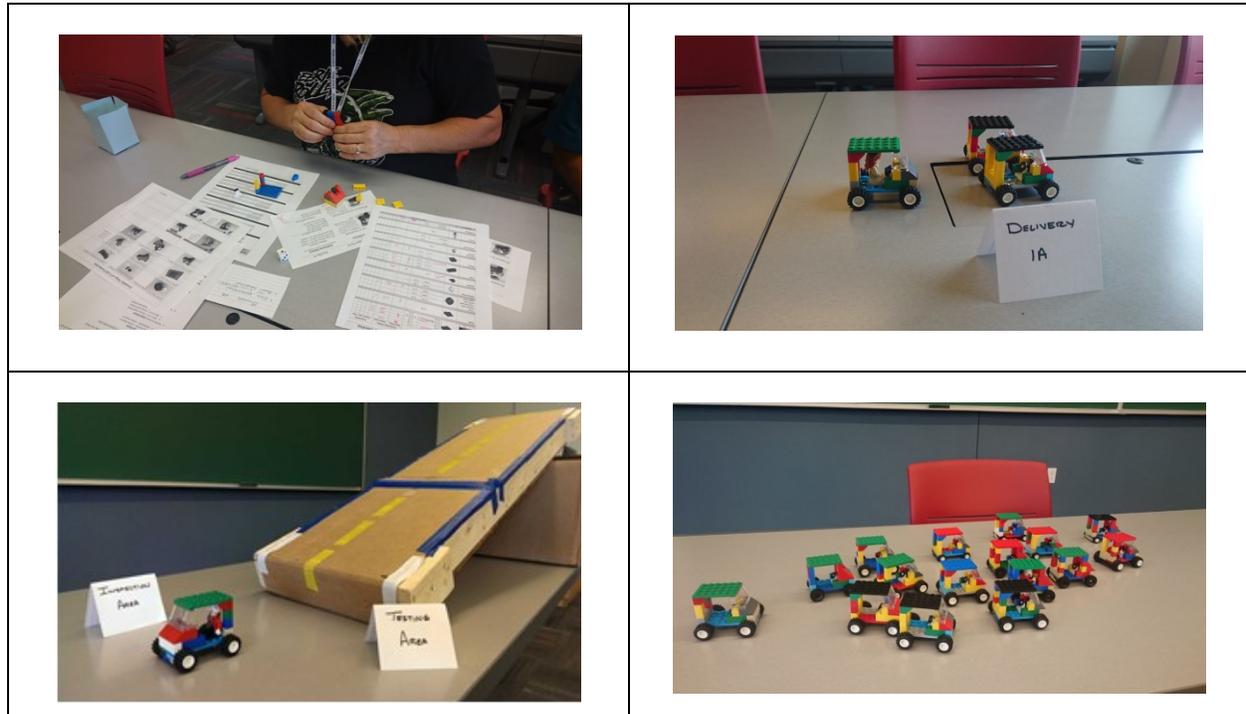


Figure 6. Pictures of the manufacturing simulation activity

Having identified the soft skills employers look for in applicants, this paper presents soft skills development workshops and simulations designed to improve these skills in participants and can be integrated with manufacturing hands-on activities. An effective soft skill development workshop will demonstrate the importance of the skill, present the current state of science concerning the skill and its development, and allow participants to practice the skill in a realistic setting, involving scenario that immediately demonstrates the benefit of the skill. Herein are development workshops for teamwork, communication, time management, and problem solving which are the skills found in at least 25% of job listings at both education levels. A future study will document the success of these in improving the intended soft skills. Four-year and higher education programs should additionally consider leadership; and high school, vocational, and two-year programs should develop flexibility.

**Marshmallow Challenge:** invented and developed by Peter Skillman of Palm Inc., and popularized by Tom Wujec in a 2010 Ted Talk, this activity reinforces many of the desired soft skills discussed in this paper. Teams of four (group size can be modified) work together for 18 minutes to build the tallest structure using the following items:

- 20 pieces of uncooked spaghetti
- 1 yard of string
- 1 yard of tape
- A pair of scissors
- 1 regular sized marshmallow

Structures must be free-standing and the marshmallow must be intact on the top of the structure. Groups will need to use communication, teamwork, and problem solving skills to be successful in this challenge. Leadership and time

management skills will also be essential to completing the task in the 18-minute window. This activity should also present opportunity for discussion on soft skills, their importance, and how they can be further developed.

**Priority Challenge:** also known as the Time Management Challenge, but changed in this study so not to overemphasize the importance of the soft skill of time management. This activity gives the administrator a great deal of freedom when it comes to design. A set amount of time must be established for the challenge (10 minutes will be used here). Students will be placed in teams of the same size (teams of four will be used here). The administrator must also create a master list of activities that would not be possible to complete in the allotted time so students will have to balance time, difficulty, and point value to make decisions on which activities to complete. Point values must be assigned to each activity, varying based on difficulty, how many group members it takes to complete, and the amount of time it would theoretically take to complete. Bonus points can be added to activities if extra requirements are completed. Activities and point values may include:

- Everyone in the group does 15 jumping jacks- 5 points
- Write down each group member's birthday in order, starting with the oldest member- 5 points
- List how many 1<sup>st</sup> cousins each group member has and provide the total- 5 points (5 bonus points for listing all 1<sup>st</sup> cousins' names)
- List on a separate piece of paper, in order, number 1-300- 15 points
- List the names of pets owned by the group, and the group member who owns the pet. The list of pet names must be in alphabetical order- 1 point per pet (minimum 5, maximum 10)

Many of the soft skills found to be desirable in our research are highlighted in this activity. Time management, teamwork, and communication are likely at the forefront. Leadership, organization, and flexibility will also be necessary to be successful. Negotiation skills, while not a focus of our research, can be implemented with activities like the following:

- Get someone from another group to take a picture of your entire group and show the picture to Mr. Smith before the activity ends- 5 points
- Take a picture of another group lined up shortest to tallest and show the picture to Mr. Smith before the activity ends- 10 points
- Convince a member of another group to join yours-15 points (can only be done once. All group lists must be updated to include your new group member to receive those points)

At the conclusion of the activity, students can be assessed formally or informally. Points should be tallied to declare a winning team. Discussions on which strategies worked or did not, as well as which soft skills were used can take place.

**No-Hands Cup Stacking Challenge:** the soft skills of communication and teamwork are emphasized in this challenge. Participants are placed on even teams (4 or more will be used here). The administrator will need to prepare a device (pictured at right in figure 7) that ties string about 1.5-2 feet long around a rubber band. Each group member should have one piece of string. They will use the string to pick up, maneuver, and release plastic or paper cups in a pre-determined design. The two designs are shown in Figure below.

It should be made clear that students are not to touch the cups with anything but the rubber band device, even if a cup falls on to the floor. Similar to the Priority Challenge, the No-Hands Cup Stacking Challenge gives the administrator and even students the ability to use their creativity. Different designs may be used to increase difficulty, therefore further emphasizing communication and teamwork skills. To develop non-verbal communication skills, and even emphasize and appreciate the importance of verbal communication, the challenge may be completed with no verbal communication allowed.

A winning team can be declared based on which team finishes each design first. Students may also be assessed on their participation in the activity. Also like other activities, a discussion should take place at the conclusion where students can offer opinions on why their team did or did not succeed. The importance of the soft skills used should also be emphasized.



Figure 7. Illustration of no-hands cup stacking challenge

## 5. Conclusions

This paper presented an analysis of soft skills in manufacturing and identified the common skills that manufacturing workers need to succeed in their jobs. A survey of the current manufacturing job postings was conducted to collect relevant data. The analysis showed that the three common soft skills for manufacturing jobs are problem solving, communication, and teamwork. The study proposed integrating the soft skills into manufacturing simulations which involve participants working in groups while their soft skills are measured and analyzed.

Future work will focus on collecting more data about the soft skills in manufacturing and developing performance measures that can be used to assess these soft skills.

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## Biographies

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