Small Businesses Present Opportunities for Engineering Students

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Abstract - **Due to the current prolonged economic recession of the Unites States economy many large engineering and industrial companies are substantially reducing their work force as well as terminating employment recruitment programs and entry level positions within their corporations. This as a result, has left many undergraduate engineering students seeking co-op positions and newly graduated engineering students seeking an entry level position with few or no employment procurement options. Large well known engineering and industrial corporations are actively reducing work forces and have little need for young undergraduates or newly graduated engineering personnel at this time. As a result, entry level employment positions at large companies are normally few and highly sought after. Small engineering or manufacturing businesses on the other hand have unmet needs which are ideally suited for undergraduate or newly graduated engineering individuals and their talents.**

INTRODUCTION

In light of the high degree of competition for the relatively small number of available positions, young engineers must be able to think outside of the box and create their own employment opportunity in these tough economic times. This article describes the benefits and opportunities small businesses offer over larger companies with regard to both employment procurement and learning experience opportunities for young engineers. Unlike large corporations, small businesses are a relatively untapped resource which offers young engineers a much broader work experience due to their small staff sizes. Likewise, engineering students and newly graduated engineers offer skill sets and benefits to small businesses that senior engineers do not provide and may struggle to accomplish. Salaries for young engineers are also inexpensive compared to senior engineers and co-op students require no added expense of health benefits or unemployment compensation when their assignment is completed. Furthermore, young engineers are incredibly computer savvy, versatile, and open to new ideas and training.

BACKGROUND & MOTIVATION

The motivation for this paper came from depressed economic conditions in the state of Michigan and the effect it has had on engineering student's ability to find cooperative positions and entry level employment. Many of the large automotive and engineering corporations such as Ford, Chrysler, General Motors, DTE Energy, and many more have either drastically reduced or ended their student engineering recruitment programs. The author has been fortunate to have three successful internships and three successful co-op assignments with the same automotive corporation spanning a seven year period starting in high school carrying through college. However, as a result of that company's recent bankruptcy, all young engineers in the recruitment program were let go with no prospect of future employment with that automotive company. Many other engineering students throughout the state of Michigan have experienced a similar fate. This has left many current undergraduate students without an opportunity for co-op employment, which is required by many college curriculums for graduation, and newly graduated students with little prospect to find a full time entry level position.

Newly graduated and undergraduate engineering students have qualities and skill sets which make them highly useful and effective additions to any corporation. While young engineers have little actual on the job experience, they are extremely proficient in computer research, technically versatile, and relatively easy to train on computer based systems. Furthermore, the employment compensation for a young engineer is substantially less than that of a senior engineer. Co-op students have the added benefit of requiring no health benefits during their course of employment and no unemployment compensation after their assignment is complete. However, the job assignment offered by an employer must also be a good match for the engineering student to facilitate a beneficial and quality learning experience. The engineering assignment must be structured to generate positive outcomes in three key areas: student competencies, useful productivity, and retention into the workforce [1]. With these essential student and assignment qualities and benefits identified, the author sought to find the best suitable opportunity available to young engineers where they would be presented with an interesting and educational work experience but also be a valued addition to their employer.

WHAT STUDENTS OFFER SMALL BUSINESSES

Small engineering and manufacturing companies have unmet needs which young engineers are ideally suited to meet. In Michigan these companies are typically tool and parts suppliers which are heavily dependent on their customer base of larger manufacturing companies and automotive manufacturers such as Ford, General Motors, and Chrysler. To better understand the thought process and needs of struggling small businesses in Michigan, two separate companies were selected for study. The first, which will be referred to as Company A throughout the course of this paper, is a tooling company. Company A specializes in making and servicing special application cutting and machining tools. The majority of their business is with Chrysler and Ford automotive, both manufacturing and servicing machining cutting tools for the production of cylinder heads, engine blocks, and other automotive components. The second company, which will be referred to as Company B throughout the course of this paper, is a CNC machining company which produces parts and various components for various customers, typically automotive. After touring both businesses and discussing at length with the owners it became clear that while both companies are in different businesses, both wanted or needed to diversify but both were working under the same constraints. Due to the current economic recession, significant decreases in domestic auto sales, and the consequent bankruptcy of both Chrysler and General Motors [2]; both businesses have found themselves with reduced demand for their product(s). Business diversification was not necessary before the effects of the recession hit; now both of these small businesses are faced with the momentous task of diversifying their product and consumer base in order to stay in business.

The benefit (and curse) of small businesses is their relative size and resources. Unlike major corporations which have stock holders and a large board of directors, small businesses are typically only owned and operated by one or two individuals. This makes it relatively easy for the business to change its business or product strategy. However, unlike large corporations which have a large number of consultants and marketing experts at their disposal, typically the small business owner(s) are the only person(s) responsible for bringing in new customs or other forms of business into diversify the company. The economic recession has forced both Companies A and B to significantly cut back their work force due to the decrease in customer orders and subsequent drop in sales. As a result, there are no funds available for most business to hire the services of business consultants and marketing experts to diversify their business. Small businesses could dramatically benefit from an inexpensive and computer savvy individual who could understand the engineering and manufacturing capabilities of a particular business and aid the business owner(s) in running and diversifying their company.

A college engineering student offers a small business owner an all purpose set of hands and a mind which they can utilize in any manner they desire to aid or improve their business. As in the case of Company A, the owner needed someone who could proficiently search for other potential markets and applications for their products and services. This opportunity allows a young engineer to gain in depth knowledge of the processes required to manufacture a company's product(s) and specific product(s) performance attributes. Once the student has learned and understands the company's process and product capabilities and applications the young engineer can use their computer research skills to seek out and find new potential markets for existing products or new products to match current manufacturing capabilities. Company A for example specializes in manufacturing low volume specialty cutting tools. The cutting tools are made from hardened steel and can be fitted with either polycrystalline diamond or cubic boron nitride tip inserts to increase the longevity of the cutting edge. An example of a typical specialty cutting tool produced by Company A is show in *Fig. 1* below.

FIGURE 1
COMPANY A PRODUCED SPECIALTY CUTTING TOOL
www.dumbartontool.com

Currently the majority of Company A's customers are in the automotive industry. In order to diversity his company's customer base, Company A's owner wants to expand his business into the medical, alternative energy, aerospace, or homeland defense industries. However, as a result of time constraints from his current obligations and responsibilities, the owner has little time and effort available to devote to investigating and researching new fields of industry.

The computer research skills of a young engineer could be utilized to investigate new fields of industry and provide small business owners with specific options for new markets or products that fit the small business's current manufacturing capabilities. In the case of Company A, the young engineer could investigate what applications there are in the medical industry for specialty cutting tools. It was found both dentists and surgeons use steel specialized cutting tools during their procedures. An example of a variety of surgical cutting tools is shown below in *Fig.* 2.

FIGURE 2
SPECIALTY SURGICAL CUTTING TOOLS
http://www.prowital-canada.com

As can be seen in *Fig. 2* the specialty surgical cutting tools are remarkably similar in both size and shape to the current specialty cutting tools produced by Company A shown in *Fig. 1*. Presented with is knowledge the owner of Company A could then decide to further investigate the potential viability to venture into the surgical cutting tool field or have the engineering student research and discover other potential diversification options.

At Company B, the owner wanted someone to train and aid him in the time consuming process of analyzing, filling out, and electronically submitting bids for state and federal government contracts. The entire process was extremely tedious and required careful and knowledgeable expertise. The owner of Company B stated that the contract forms are in their own "language" so to speak and have to be filled out and completed correctly otherwise the contract bid will be disqualified from consideration. The owner of Company B was the only one at his business educated in filling out the contract bid forms but has difficulty finding time to fill them out with the other responsibilities and obligations of running his business. The owner of Company B further stated that none of his shop floor workers have the computer skills or desire to learn the process. This opportunity allows a young engineer to utilize their computer skills and gain valuable knowledge and experience in the business and financial aspect of engineering. Once the engineering student becomes proficient in the process and system, the owner of Company B would have more time to devote to other matters required to run his small business.

However, both owners wanted an extra set of hands which could aid in producing products when the work load increased do to these unsteady times. While small businesses do have to invest time and money into training a young engineer, like any employee, there is little risk involved. If the co-op student doesn't work out, then at the end of the assignment s/he is done with the company with no further financial obligation for the business owner. If the co-op student proves to be a beneficial asset to the company, s/he can be hired part time while s/he attends school, come back for future assignments, or be extended a full time position.

ADVANTAGES FOR STUDENTS AT SMALL BUSINESSES

Cooperative assignments between students and non-university affiliated businesses provide students with experiences and opportunities to advance their development in a manner unattainable in the classroom. "Because the classroom is a part of a university setting, not a corporate setting, it is limited in context and scope and can only provide a limited simulation to real life work situation of an engineering professional" [3]. The entire scope of responsibilities which are demanded from and performed by engineers throughout the engineering design and production process is beyond a university's capabilities and resources. As can be seen in *Fig. 3* below, the engineering design process involves skills and techniques which include strategic coordination, communication, and business analysis; as well as engineering.

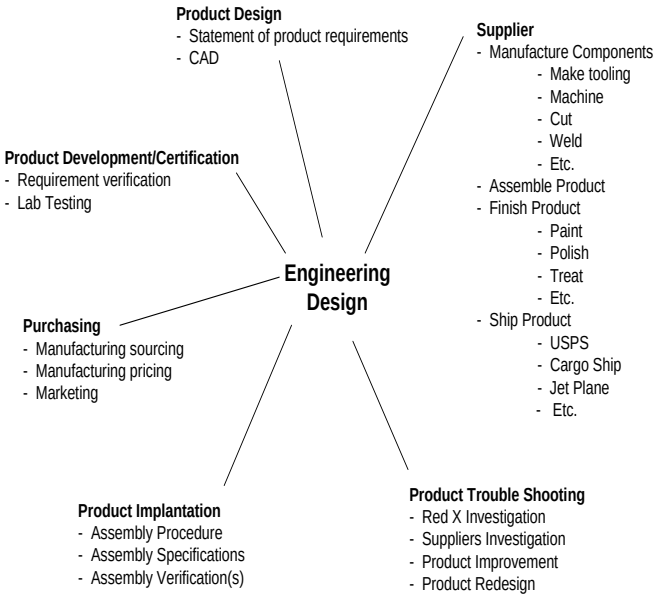

FIGURE 3
SCOPE OF DESIGN ENGINEERING PROCESS

While different companies have different systems and methods for managing and performing their engineering product design, all companies large or small that produce and manufacture a tangible product must go through the same basic process. Large corporations, which typically have multiple products, facilities, and human resources are able to divide the responsibilities of the design and manufacturing process over their entire large field of operations.

Young engineers at large corporations are normally assigned to one particular group or department throughout the duration of their assignment, which only exposes them to one very small aspect of the entire engineering design and manufacturing process. The author has experienced a variety of engineering work assignments through his

combined six internships and co-ops with the same automobile manufacturer. The assignments ranged from lab technician, water intrusion testing engineer, fuel systems engineer, tire and wheel engineer, manufacturing quality engineer, and crash safety engineer. The job responsibilities and engineering techniques at each particular assignment were direct and methodical but drastically different between assignments.

Both the lab technician and water intrusion testing engineer assignments focused on product development and certification aspects of the engineering process. The job responsibilities for a lab technician included building test fixtures to systematically run components for a set number of cycles or until failure. The parts were inspected at regular intervals throughout the test duration and observations on the integrity were record. After the component had completed the full test matrix or failed, the senior engineer responsible for the part was contacted and notified of the results. Any further action was decided solely by the engineer responsible to the part design. The job responsibilities for a water intrusion engineer required preparing vehicles for water testing by removing their interiors, photographically documenting the engine air induction system and under body, as well as installing a small video camera inside the vehicle's air induction system. The camera was installed to allow the author to monitor the amount of water intrusion into the induction system during testing. In the event a vehicle's air induction system was compromised during testing and a large volume of water was ingested into the induction system, the camera alerted the author to this fact; allowing him to shut down the vehicle's engine before permanent damage could occur. The test conditions for each vehicle were determined by a standard test matrix that stated the run number, order, vehicle speed, and water depth throughout testing. Similar to a lab technician, periodic inspections were conducted at regular intervals throughout the test duration to monitor the integrity of the vehicle's air induction system. Any water intrusion or anomalies that were found during inspection were recorded. Vehicle testing was completed after the full test matrix had been run or the induction system failed by ingesting what would be a catastrophic amount of water. All photographs, data, and recorded observations taken throughout the investigation were organized into a standard report format and presented to a senior engineer.

The scope of both product development and certification assignments focused on systematically testing vehicle systems or individual components. No insight was provided as to the cost or manufacturing details of tested components. Little or no insight or feedback was provided by engineers in regard to the detailed aspects of the component or system design before or after testing. Any decisions in regard to system or component design changes as a result of testing were executed and performed by the design engineer responsible for the part or system. From two assignments it was concluded that the responsibilities of a lab technician and validation engineer were confined to preparing, running, and recoding test results. The justification behind the test length and conditions as well as the test results were responsibilities for the product design engineers and their respective departments.

Fuel system engineering and tire and wheel engineering assignments focused on product design engineering. Both assignments required using computer aided design software to model various parts and components. Communicating with secondary suppliers to solicit and receive pricing quotes. Requisitioning, planning, and organizing systematic validation testing for prototype component designs. Analyzing and interpreting test results and modifying part designs as needed. Contacting dealerships to inquire and investigate customer quality claims. Once a part design was modeled in CAD, price quoted, and validated; the project was turned over to a senior engineer to review and implement into production.

The scope of both design engineering assignments focused on computer modeling parts or systems and then organizing and supervising various other aspects of the engineering process. Throughout both assignments the majority of time was spent generating and modify components and systems in CAD. Communicating with suppliers and lab technicians was a key aspect of the assignment but little insight or detailed information beyond component specifications, pricing, and test data was provided and available. Product implementation with plants and assembly workers was handled by senior engineers and no experience or knowledge was provided on the required process.

The manufacturing quality engineering assignment was carried out at a vehicle assembly plant and required systematically and statistically investigating build quality issues to find their root cause and propose potential solutions. Quality issues were identified by factory inspection, dealer inspection, or customer quality reports. The root cause of the issue had to be clearly identified and attributed to part design, part deviation from specifications, part variation, or operator installation. Quality investigations involved communicating with senior design engineers, part suppliers, and assembly operators. Investigations also involved reading component design histories, finding detailed part specifications and build draws, inspecting and testing samples of supplier parts, and observing operator installation processes. All quality investigations were conducted using a published and commercially available systematic quality control measurement and data analysis system. After the necessary data was taken and the results analyzed and interpreted a final report was published on each quality investigation. Depending on the root cause of the issue, the senior design engineer responsible for the component or system was responsible correcting the issue with the design or supplier quality. It was the responsibility of plant management to correct or address and issues attributed to operator installation process.

Crash safety engineering focused on the regulatory aspect of the engineering process. The majority of assignment was spent reading federal reports and regulations which specify stringent test conditions for a various vehicle impact situations. Stationary or mobile test fixtures were then designed to meet or exceed the standards or criteria set by federal regulations. Crash fixtures were modeled in CAD and then detailed build drawings were produced. Assignments responsibilities included requisitioning materials and working with fabrication technicians to build or modify crash fixtures as needed. Finished crash fixtures were inspected and validated to meet regulations and used in full scale vehicle crash safety testing.

The Crash Safety Engineering design process and philosophy was unique compared to all other types of engineering assignments the author experienced. Crash fixtures were one off builds as opposed to mass production parts used in automotive applications. Since it was not economically feasible to repeatedly test crash fixtures to evaluate the robustness of the design, crash fixtures were intentionally over engineered to produce "bullet proof" design performance. Since all crash fixtures were designed, built, and manufactured in house the author was able to perform and gain experience in purchasing and project price quoting. There were also few limitations in regard to design form and spacing, which allowed the author more design freedom to be creative and experiment to produce the better performing and quality engineering designs.

From the six completed assignments the author was able to experience and participate in most of the aspects of the entire engineering process. However, there are still aspects of the engineering and manufacturing process such as product implementation, marketing, and business research the author was not able to get adequate exposure to over his six cooperative and internship assignments. The nature of large corporations that produce thousands of products and have a large field of operations allows them to divide the various aspects of the engineering design and manufacturing process up into individual departs. Each department is responsible for their own aspect of engineering, designing, producing, validating, or manufacturing a specific component or system. This engineering philosophy along with the limitations of the classroom to effectively expose young engineers to the entire engineering design and manufacturing process leaves students without a strong fundamental engineering base to utilize in order to plan their future career path [4]. Engineering students are forced to participate in multiple assignments in various departments within a large cooperation to get as much exposure, experience, and knowledge as possible in the entire scope of the product design engineering and manufacturing process.

Small businesses, on the other hand, normally produce a very limited number of products and have relatively small and limited facilities and human resources. As a result, typically the entire engineering design and manufacturing process is accomplished and carried out all under one roof. This is an immensely beneficial scenario to young engineers who have yet to be exposed to the scope of the entire engineering process. The owners of Companies A & B proclaimed their desire for an individual who is willing to participate in all aspects of the company's business when additional aid and support is needed. The owner of Company A stated that the unstable economy has produced a feast or famine trend in sales. Instead of ordering a steady number of parts over a long period, customers are sporadically ordering large number of parts in one order. Company A's owner as a result cannot justify increasing its workforce to fill the large one time order but is also strained to fill the order with the limited work force on hand. The owner of Company A stated that it would be beneficial to him if he had someone who could help him in diversifying his customer base when production is slow, but could be placed on the line and aid in fabrication when production volume is high. This allows a young engineer to get exposure to the various aspects and responsibilities of the engineering design and manufacturing process, plus experience how the various aspects interact to develop and produce a finished product. Small businesses allow the individual to get first hand exposure to the design, development, production, and marketing aspects of the engineering process to a degree which is typically unavailable in large corporations.

The toughest part of finding a job in the current economic climate is just getting the opportunity. Large corporations typically only take online applications and it is almost impossible to contact and speak to the employer unless they initiate the contact. However, as mentioned before small businesses are typically owned and run by only one individual, it is relatively easy for young engineers to get in contact and communicate with that individual and discuss the possibility of employment. Just as with large businesses, there is no guarantee a student will find employment at the first business they contact or apply to, or any for that matter. However, unlike at large companies the student is able to initiate the communications and speak with the very person who is able to provide them with an employment opportunity. This benefit allows the young engineer the opportunity to make an impression and be a person with a name and voice and not just another electronic resume submission.

RECOMMENDATIONS

From the author's personal job experience and research the author would strongly urge engineering students and newly graduated engineers to pursue small businesses for initial employment, even over large corporations. The engineering design and manufacturing process is a broad and diverse one that has many various aspects which all young engineers should be exposed to. Unfortunately, the university setting cannot expose young engineers to the responsibilities and natures of these various aspects; and to a point neither can large corporations. Large corporations are often national or global in their operations making it impossible to see all

aspects of product design, refinement, sourcing, purchasing, testing, manufacturing, and marketing. In a small business a young engineer could be exposed to and possibly participate in all of these aspects to some degree, and then decide what they enjoyed and what they would like to pursue with future assignments or employment. Young engineers would also gain exposure to the work environment that small businesses offer, gain valuable job experience and knowledge, and then take what they have learned and gained to later seek employment at a larger corporation if they so choose.

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