

Engineering Management  
Field Project

# **Outsourcing the Design of Structural Building Components**

By

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Master of Science

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Finally, to my children, Allison and Andrew; I am happy to be completing my masters degree so that I will be able to spend more time with you.

Of special note, my wife and I are currently expecting our third child. While we do not yet know the gender, he or she is expected to make his or her debut literally any time. It is my hope that my paper submission and

presentation is approved prior to that time. I look forward to welcoming this new addition to our family, and hopefully can say that I am a KU graduate by that time.

## **Executive Summary**

As the outsourcing phenomenon spreads to the structural building components industry, there are exciting possibilities ahead for component manufacturers. Along with these possibilities come tough management decisions, regarding if, when and how to capitalize on this opportunity. This opportunity is presented at a unique time when the industry is at historic lows. Tapping into an increasingly broad technical workforce in India may be a way to overcome domestic issues which hamper profitability.

This project contains an examination of the tasks associated with the design of structural building components. These tasks are evaluated to determine the feasibility of outsourcing any or all “core competencies” to a consultant which employs design technicians working in India. The conclusion establishes a rationale for the recommendation to keep component design work stateside.

## 1 Introduction

The outsourcing of structural building component design has recently become available to component manufacturers in the United States. These manufacturers of metal plate connected (MPC) wood roof trusses and floor trusses and structural wall panels have the opportunity to cut overhead and administrative expenses. This may be accomplished by having these components designed by a degreed technical professional working in a third world country, such as India. Additionally, outsourcing in the design process could hold promise as a means to effectively smooth the peaks and valleys of the design staff's workload.

The outsourcing process begins when the truss manufacturer scans construction documents and sends them electronically to a contractor's office in the U.S. The contractor would then forward the documents to their offshore design office. A foreign designer would complete the design with supervision by a U.S.-based project manager. The electronic truss design files would then be sent electronically back to the truss manufacturer.

To structural building component manufacturers, the design of their products is an integral part of their business, or a "core competency." The outsourcing of this core competency is contrary to the basic premise of "do what you do best, and outsource the rest." Outsourcing is typically relegated to mundane tasks or those tasks which are not part of a business's core.

This project includes an analysis of the effectiveness of outsourcing as a means of fulfilling the design requirements of MPC wood trusses. Although

this report does not evaluate other structural building components (i.e., i-joists, engineered wood beams and wall panels), the analysis provided here would also be applicable to those components.

The design tasks to be evaluated in this report include truss system modeling, model optimization, individual truss rough design, truss chord splicing, web pattern optimization to minimize the number of webs and web length optimization to minimize scrap. The various tasks required in the design process are broken down to determine which, if any tasks may be completed by a foreign work force. Since this is a new realm, the success and failures of outsourcing in similar industries has been researched and these outcomes have been extrapolated to the structural building component industry.

The results and conclusions drawn from this evaluation lead to a recommendation to structural building component manufacturers regarding whether or not to pursue the outsourcing of component design. Additionally, this report makes recommendations regarding the design tasks which would most effectively be outsourced.



## 2 Literature Review

There has been much information published regarding outsourcing. A large number of these publications have dealt with outsourcing in Information Technology (IT) and Human Resources (HR). This is most likely because IT and HR are typically ancillary departments within a company. However, engineering design and product development outsourcing is becoming more common.

The literature review for this project is exclusively on the topic of outsourcing. This is because there is very little literature available related to structural building component design and outsourcing. The research into the component design aspect is left to personal experiences, discussions with peers and consultation with a new building component design outsourcing firm.

1. Alan S Brown, *Where the Engineers Are*, Mechanical Engineering, Vol. 127, No. 6, June 2005, pp. 26-31.

Brown explores the outsourcing of mechanical design services to India. In his first example, Elkay Manufacturing Co. of Oak Brook, IL, began outsourcing by sending 2-D legacy CAD drawings to be converted to Solid Works 3-D models. The goal of the project was to create a library of models that Elkay engineers could use to design new products much more quickly.

In Brown's second example, he notes how General Motors (GM) has established an engineering presence in China. This comes as the result of GM's emerging market presence in China. The company simply needed to

have engineering resources to support customers and local suppliers. GM's engineering center also began by doing CAD conversions and finite element analysis (FEA), but has since progressed to engineering new car models from the ground up.

In both of these examples, Brown stresses that it is important to keep core knowledge and skills in-house. Both companies used outsourcing as a cheap method of completing repetitive, yet technical tasks, at least initially.

Brown goes on to describe the inherent risks involved in outsourcing product design tasks. The chief concern is intellectual property theft. The American company has no recourse against an employee of the foreign contractor who goes to work for the American company's competitor and takes valuable "trade secrets" with him or her. Moreover, this theft of intellectual property may be difficult to prove, unless the American company can not only document that their trade secrets have been stolen, but also that these secrets are being used and/or implemented by a competitor. This process, and the ensuing legal battle, would be not only costly, but time consuming. In contrast, because intellectual property laws are swiftly and summarily enforced in the U.S., this problem is of less concern when working with contractors stateside.

2. Terry Costlow, *Engineering Goes Global*, Design News, Vol. 61, No. 16, November 6, 2006, p. 35.

In this article, Costlow discusses the growing trend of outsourcing engineering and programming to third world countries, such as India. As a

result of this trend, U.S. engineers are focusing their career paths on jobs that are more difficult to outsource. American colleges and universities are also stressing innovation and the entrepreneurial spirit in their engineering curriculum. For suppliers, keeping engineers close to their customers is also a concern.

3. Bruce Stokes, *Aerospace Jobs Landing in Asia*, National Journal, Vol. 39, No. 6, February 10, 2007, pp. 58-59.

In his National Journal article, Stokes cautions Western companies against sending too many of their core competencies off-shore. Commercial aircraft companies are increasingly sending their design and manufacturing operations to China and Japan. As a result, companies such as Boeing and Airbus are becoming aircraft marketing and sales businesses, rather than aircraft manufacturers.

4. Stan Gibson, *Is India's Edge Fading?*, eWeek, Vol. 23, No. 29, July 24, 2006, p. 14.

Gibson addresses the shrinking benefits of outsourcing to India. The obvious issue in shrinking India's edge in outsourcing technical work is wage inflation. With the explosive growth of technology-related jobs in India, the demand for highly qualified workers has skyrocketed.

In 2006, Infosys Technologies, one of the largest IT and business consulting firms in India, reported an increase in average starting salaries from \$5,122 to \$5,763, which is a 12.5 percent increase. Infosys plans to address this problem by pumping hundreds of millions of dollars into a

training program. The goal is to keep attrition to a minimum by offering a very good learning and working environment.

Although India's competitive advantage is shrinking, their initial gap was enormous. Wages are increasing at a rate of 12 percent per year in India. When this is compared to a 4 percent increase in the United States, it will take until the year 2032 for the salaries of the respective software engineers to converge. Obviously, salary increases for the two countries will approach equilibrium as salaries become more equitable.

5. Sarah Fister Gale, *Role Reversal*, PM Network, Vol. 22, No. 1, January 2008, p. 12, 14.

Gale examines an unusual strategy by Wipro Technologies Ltd. One of the largest software development and outsourcing firms in India, Wipro, has plans to open an office in Atlanta, Georgia. They are seeking to gain a competitive advantage by having local people do work which requires a better understanding of U.S. business and culture. This U.S.-based office will also allow Wipro to bid on government projects that require local programmers.

Other benefits of a more regionally located operation include all of the following: similar time zones, shorter commuter flights and a better understanding of the local culture. Gale also points out that the 18.7 percent salary increases for Indian software professionals in 2007 is making outsourcing to India less attractive.

Wipro has also recently expanded into Mexico. The office in Monterrey employs 100 workers to service North American and European clients.

Operations in Mexico provide “near shore” services to clients in the U.S. at labor rates that are attractive.

6. Rajabhadur V. Arcot, *Engineering in India*, Machine Design, Vol. 79, No. 21, November 8, 2007, p. 94, 96-9.

Arcot provides a profile of the typical engineer in India. He also describes the typical work week, the required college education and the job market for engineers in the exploding high-tech economy. Indian engineers have come a long way since the 1950’s, when the starting salary, in American figures, was a mere \$120 per year. By 2007, the average salary had grown to approximately \$10,000-\$20,000 annually.

One concern of note is that the explosive growth in software engineering has led to deficiencies among other engineering-related disciplines. Established engineers are leaving their fields to become programmers. Likewise, software companies that once only hired the “cream of the crop,” are forced to recruit graduates with lower academic performances.

Another interesting point is the great significance placed on entrance exams for engineering institutions. All entering students take the Common Entrance Test (CET). Besides having a better choice of schools, students who score well on the CET receive great monetary rewards. Students who score poorly on this test may pay as much as twenty times the tuition as students who score the highest.

7. Michael Gamble and Chris Hediger, *Outsource from the Inside*, Pharmaceutical Executive, Vol. 28, No. 1, January 2008, pp. 36-7.

In the pharmaceutical industry, a great deal of research and development is performed in a clinical setting. In this setting, many mundane and routine tasks are performed by highly skilled scientists and engineers. As a result of this, the authors examine a new twist on outsourcing in this industry.

On-site scientific teams, managed by a solutions provider, are formed on company premises. In-house staff members are then freed up to perform more critical work. This service arrangement gives the client greater control over the work of the contractor. It also improves the communication between all those involved, because there is face-to-face interaction. Finally, clinical teams can offer a cost savings compared to traditional outsourcing because the pharmaceutical firms can use their own overhead and equipment, for which they have already invested.

8. Dan Carnevale, *Technology Companies Bring Outsourcing Home*, The Chronicle of Higher Education, Vol. 52, No. 31, April 7, 2006, p. A43-4.

Carnevale explores an innovative American company hoping to slow the outsourcing of IT jobs to foreign countries, such as India. Rural Sourcing, Inc. is establishing offices in rural U.S. college towns where schools and universities have large numbers of graduates in computer-related fields. Rural Sourcing sees this pool of talented, inexpensive labor as a means of keeping outsourcing inside the U.S. In other words, college graduates who

live in rural areas may desire to remain in those areas, following graduation. Although these graduates could earn higher salaries by relocating to a metropolitan area, they may prefer to live or remain in suburban communities, small towns, rural areas, etc. As a result, employers, such as Rural Sourcing, can remain competitive in their hiring, but still employ these rural graduates at a lower salary, as compared to graduates living in major cities who would require higher salaries due to increased cost of living, etc.

Rural Sourcing also targets those students who are interested in an IT field, but don't see a way to pursue a computer programming career without moving to an urban area. Local colleges and universities could potentially generate more interest in IT degree programs because of the new market for rurally located programmers.

The founder and president of Rural Sourcing, Kathy White, is a former professor at the University of North Carolina at Greensboro and later worked in the corporate world. She has teamed her experience in both of these realms together to create the company that she now heads. Rural college and community leaders are often eager to recruit Rural Sourcing to open an office in their communities. They hope to generate a technology base, both for the school and the community. By 2006, the company had grown to employ about 50 people in three main offices, as well as two satellites, including one located in Rockport, Missouri.

9. Karen Krebsbach, *Inside the Outsourcing World of India*, United States Banker, Vol. 116, No. 12, December 2006, pp. 30-2, 34, 36, 38.

Outsourcing work from U.S. financial services firms to India will be the primary driving force in increasing the Indian gross domestic product (GDP) by 25 percent from 2006 to 2009. Virtually all large U.S. banks are turning to consultants, such as Infosys and Tata Consultancy Services, to handle software development, maintenance, and research and development. These consulting firms have created oases of organized productivity amidst the chaos of third-world India.

While outsourcing has helped to bolster the Indian economy, the country's infrastructure lags far behind that of first-world countries. The government has not shown progress in providing adequate public facilities and services. As a result, the large consulting firms are creating huge private industrial parks to provide the necessary infrastructure for their businesses. These industrial parks, located within special economic zones (SEZ's), have been promoted by trade groups and are intended to attract even more IT firms, because of the great tax benefits associated with them.

One of the risks, however, in outsourcing IT in any industry is the vulnerability of sensitive information. This is especially true in the case of banks and other financial services. As a result, outsourcing firms dealing with financial services follow strict protocols when performing IT tasks in India. Even with such tight security in place, criminal activities are inevitable. Because of this, U.S. financial firms name the U.S. as the jurisdiction and venue for dispute adjudication. However, there is no treaty between the U.S. and India that requires U.S. court judgments to be enforced in India. As a



result, U.S. companies are ultimately at the mercy of the Indian courts to prosecute criminals.

10. Corie Lok, *Two Sides of Outsourcing*, Vol. 108, No. 2, February 2005, p. 33.

Outsourcing giants in India are generating an offshoot of innovative companies led by entrepreneurs. Many IT specialists, who have earned great incomes for a few years at the large consulting firms, are leaving to start their own companies. Many of these startups are involved in product development, which the larger firms try to avoid because of the conflict of interest with their customers.

These technology entrepreneurs are often returning home to India from abroad with a great deal of knowledge gained from serving multinational clients. Many have also gained critical experience managing global operations. In addition, they are returning to a culture in India that has evolved to look favorably upon entrepreneurs.

11. Deanna Zammit, *For Help With Work in U.S., One Shop Looks to Far East*, *Adweek*, Vol. 46, No. 8, February 21, 2005, p. 10.

The New York advertising firm, Banerjee & Partners, is outsourcing creativity to copywriters in India and Singapore for U.S. ad campaigns. They propose a cost savings of forty to sixty percent, compared to using all domestic workers. The president of the firm, Dave Banerjee, believes telecommunications technology now makes it possible for foreign advertising

consultants to work on his virtual team. Critics say that there is no substitute for in-person collaboration when it comes to creativity in design.

Having Indians adopt American culture is a big step in being able to bridge the geographical gap. The cheap labor would not justify the use of Indian workers if they were not able to generate creative advertising ideas that work in or apply to the American culture. Piyush Pandey, national creative director at WPP Group's, Ogilvy & Mather, in Bombay, India, points out that "Good creative people make it a point to do that, no matter in what part of the world they live, and the not-so-good ones often ignore the audience, even if it lives around him or her." Success for Indian advertising would require an effective understanding of the American audience.

12. Kenneth Munsch, *Outsourcing Design and Innovation*, Research Technology Management, Vol. 47, No. 1, January/February 2004, pp. 27-30.

Kenneth Munsch is a director in the Creative Office at Herman Miller, an office furniture manufacturer. He explains how Herman Miller defies most outsourcing strategies by outsourcing one of their core competencies, product design. The outsourcing of design and innovation in this manner provides many benefits; this article explores these benefits in detail.

Independent, outside designers have much more latitude in solving design problems because they are not bound by as many corporate constraints. Outside designers tend to be more "free thinkers," with an entrepreneurial spirit that is often lacking in corporate employees. They also give the company a vast range of cultural backgrounds from which to draw.

Designers in Paris or Berlin will approach a problem from a much different perspective than a designer in Detroit.

In order for this arrangement to work and thrive, the company's culture must evolve into one that fully embraces these design relationships. The company must establish thorough and effective intellectual property protocols to protect the company and the outside designer. A royalty structure also must be created that places the designer's goals in line with the company's goals. If done properly, the outsourcing of design can bring new levels of innovation to a product line.

13. Kevin T. Higgins, *Outsourcing Engineering: Redefining Priorities for New Age Engineers*, Food Engineering, Vol. 79, No. 2, February 2007, pp. 32-4, 36-7.

Higgins describes the outsourcing of engineering in the food processing industry. Outsourcing has become a way of life for food engineers over the last seventeen years. However, companies are struggling to obey the golden rule of outsourcing, "never outsource an activity that is part of core competency." Outsourcing has been used as a stopgap when in-plant engineering resources are stretched too thin.

Many setup and maintenance tasks, such as controls engineering, are being sent to contractors. This leaves overall system design and integration to the company's in-house staff. Thus, the company still retains control of this core competency.

The belief that China and India are producing more engineers than the U.S. is challenged by Duke University's Gereffi and Wadhwa. They point out that published numbers of graduates in these other countries include students who have only received basic engineering training. They also classify computer scientists and IT specialists as "engineers." Gereffi and Wadhwa state that "almost one third of the globe's science and engineering researchers are employed by the United States."

Pradeep Khosla, dean of the College of Engineering at Carnegie Mellon, describes the troubling trend of worldwide engineering work hours based in the U.S. "A decade ago, close to 40 percent of total engineering hours were based in the U.S. Current predictions are that by 2010, only about 10 percent of those work hours will be in the U.S."

14. Terry Atlas, *Bangalore's Big Dreams*, U.S. News & World Report, Vol. 138, No. 16, May 2, 2005, pp. 50-2.

On the heels of call centers, computer programming and back-office operations, Indian outsourcing firms are tackling more and more technical product research and development tasks. They are also managing U.S. data centers and networks remotely. Because they don't have interaction with the western world, as in the case of call centers, the trend is happening more quietly. Many believe that the outsourcing of IT services to India is only the "opening act of a larger transformation."

Even with salary inflation near 15 percent annually, India still has an enormous cost advantage compared to the U.S. However, the Indian

infrastructure lags significantly behind that of the high-tech outsourcing campuses. The streets of Bangalore are rutted and crumbling, traffic is terrible and garbage piles litter the landscape.

Though India offers an abundance of technically skilled workers, it lacks the middle managers necessary to compete projects on time and keep the projects within budget. The huge growth in salaries has also led to “job-hoppers” who have driven attrition to increasingly high rates. These rates of attrition are up to 15 percent at premier companies, while at second-tier employers, attrition rates can range anywhere between 15 percent to nearly 40 percent. The highly analytical population is not necessarily suited to creative tasks which require consideration of the aesthetics of product design.

15. Gary S. Becker, *Have Skills, Will Travel*, Hoover Digest, No. 4, Fall 2007, p. 24-7.

Becker explains that there are other factors, besides labor rates, when considering the benefits of outsourcing to a third world country, such as India. The cost of doing business with a company in a distant land includes transportation and capital costs, which are considerably higher than for U.S. companies. Hence, the rapidly increasing salaries of technical professionals in India need not approach those of their U.S. counterparts before outsourcing ceases to be economical. Because of this loss in competitive advantage, Silicon Valley based high-tech companies are cutting ties with foreign suppliers and bringing work back home to the U.S.

The movement of highly educated people between countries has increased considerably. This is due to television and the Internet homogenizing world cultures to a greater extent than existed in the past. The low cost of international airfare also appeals to employees working abroad who still wish to travel back home regularly to visit family and friends.

This literature reviewed often contained opposing views. For example, the idea of not outsourcing core competencies is promoted in some articles, while it is refuted in others. The effects of the tremendous salary inflation in India are also viewed differently by different researchers. Some believe that the vast gap between U.S. and Indian salaries will give India the competitive advantage for many years. Other researchers believe that the advantage is shrinking quickly, when all factors are considered. These factors include the cost of doing business at a distance, such as travel expenses, time loss due to the time zone difference and management costs associated with interfacing with contractors, instead of employees.

### **3 Procedure and Methodology**

#### **3.1 Background**

Company ABC sells metal connector plates and equipment used in the manufacture of trusses. ABC also provides engineering services and proprietary software licenses to truss manufacturers which use their connector plates. ABC has long fought the notion of using “design brokers” to do design for truss manufacturers. This is primarily because it would reduce ABC’s revenue from software licensing.

A former ABC employee with extensive software and marketing experience has now formed company XYZ with the goal of providing low-cost truss modeling and/or design services to ABC customers in the United States. XYZ hopes to accomplish this by establishing teams of truss design technicians in three metropolitan areas of India.

These remote design offices in New Delhi, Kolkata and Pune, three major cities in India, are staffed by a design team (DT) of Indians. Each DT member has a minimum of a three-year collegiate engineering degree. Each of these DT’s reports to a project manager (PM) based in the U.S. These PM’s have a minimum of ten years of truss design experience. The role of the PM is to act as a liaison between the customer and the DT, to review and check work and to field questions from the DT.

Design services are billed at an hourly rate. The PM is billed at \$75.00 per hour, while the DT members are billed at \$12.00 per hour. During 2007,

XYZ's first year in existence, they billed at an average of \$17.00 per hour.

This rate may vary widely, based on the complexity of the design and other factors.

### 3.2 Modeling vs. Truss Design

“Modeling,” as defined in the MPC truss industry, is the process of doing a three-dimensional “take-off” from a set of construction documents.

The profile, or shape, of each truss is created and placed on a three-dimensional layout. Figure 1, which follows, shows the roof truss placement plan generated from the construction documents of a house.

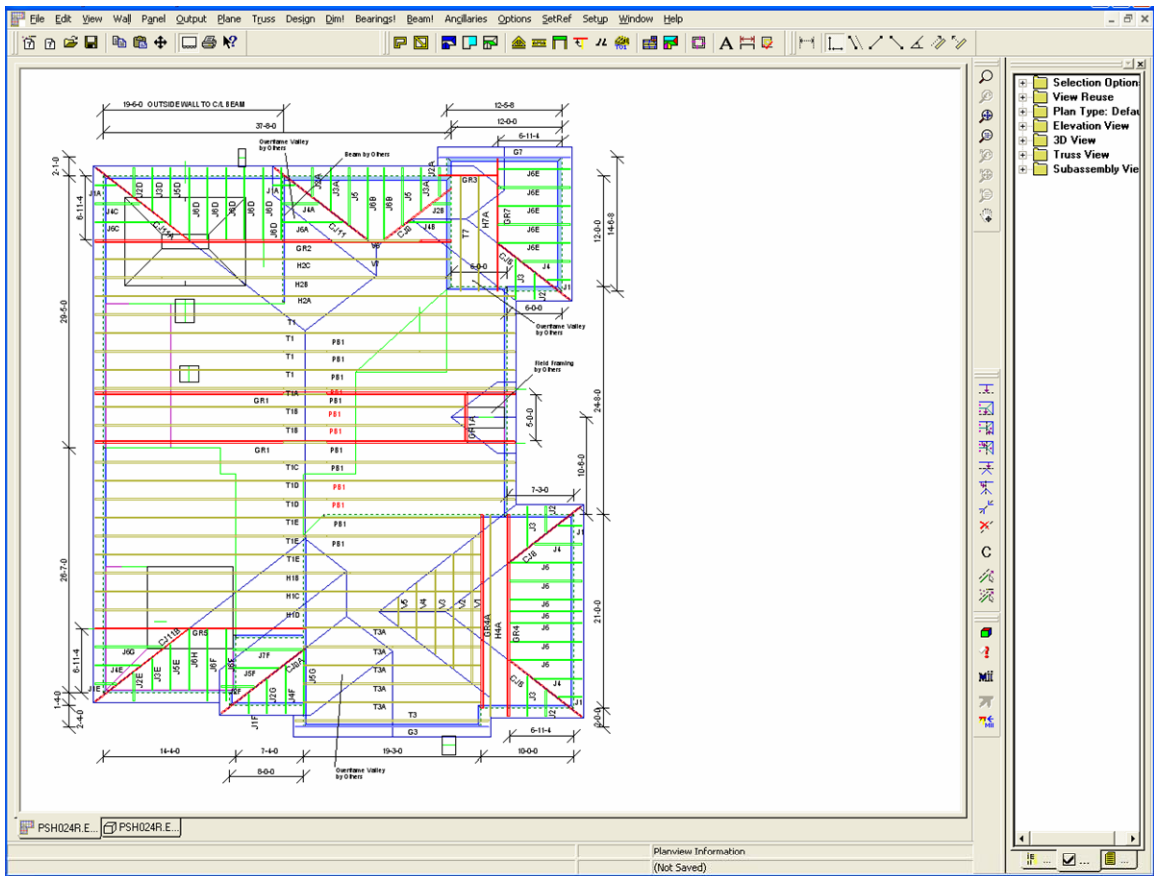
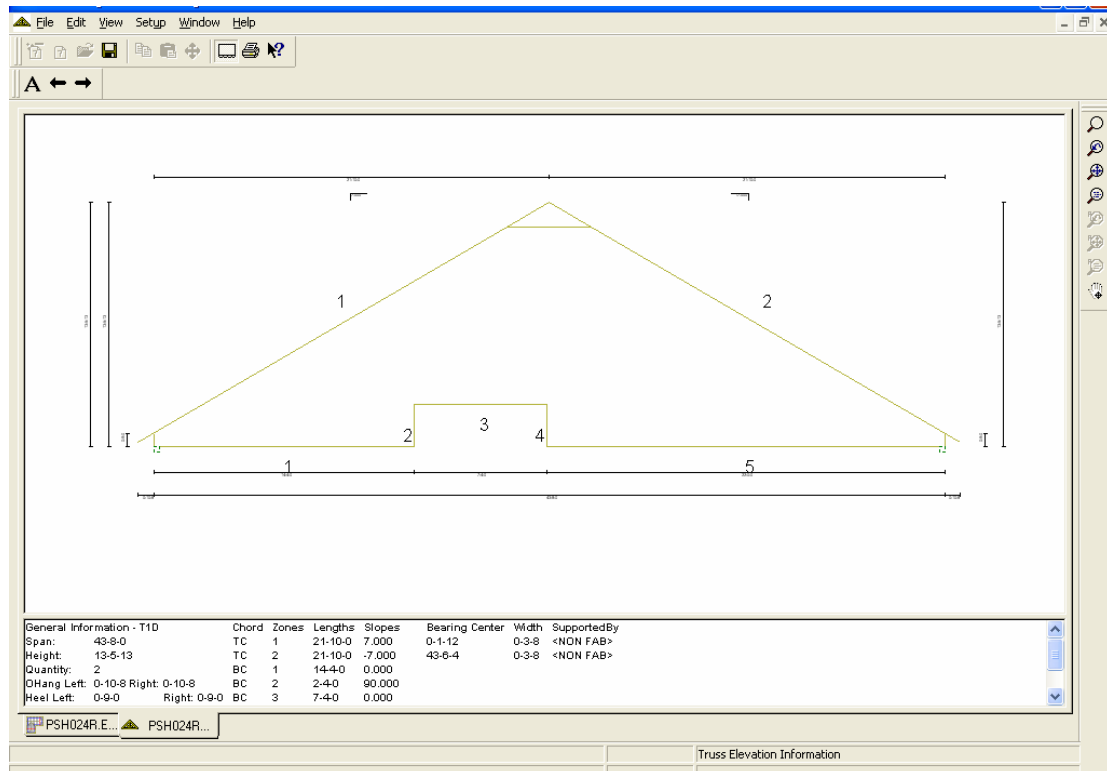


Figure 1: Modeling Plan View

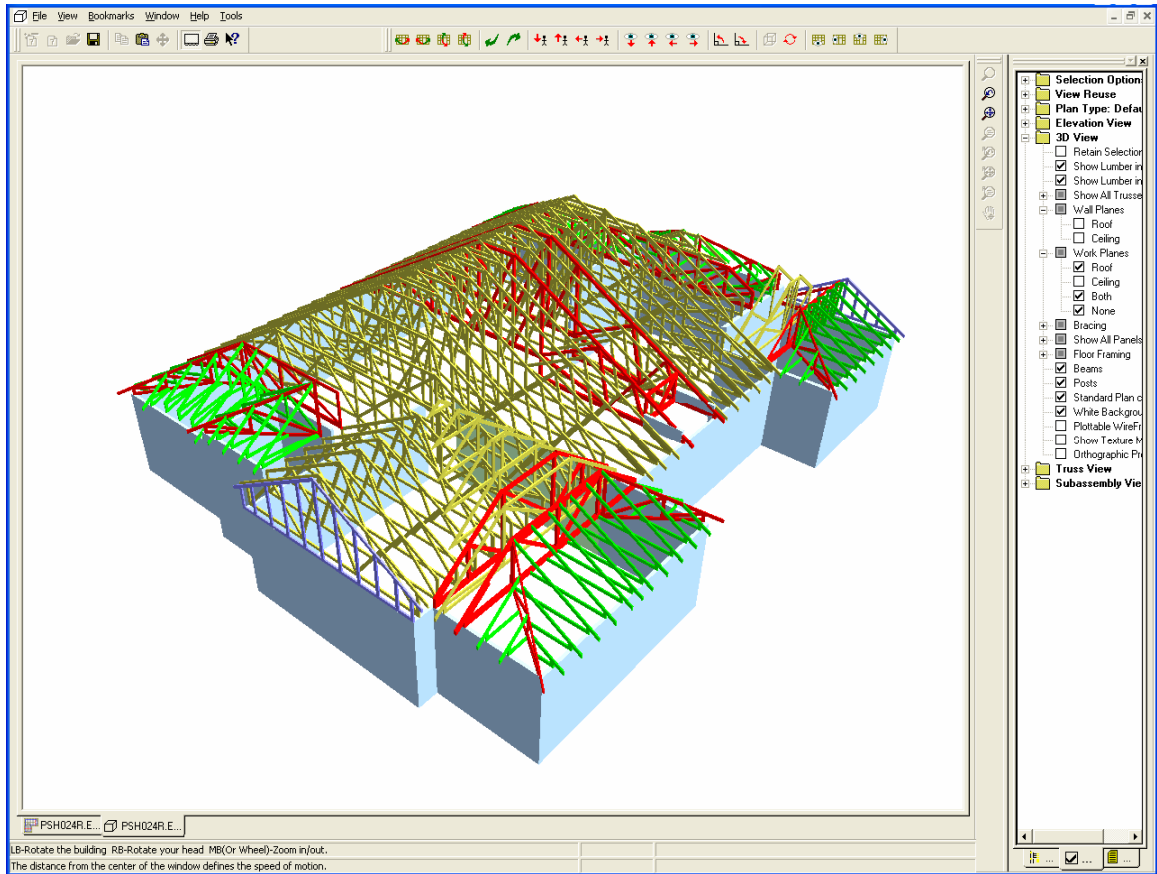


Figure 2, which follows, shows the profile of a single truss that is generated with the modeling software. Notice that the truss view shows only the basic shape of the truss, without regard to the components that will eventually makeup the truss (i.e., lumber and connector plates). The lumber and connector plate selection will be done later.



**Figure 2: Modeling Truss View**

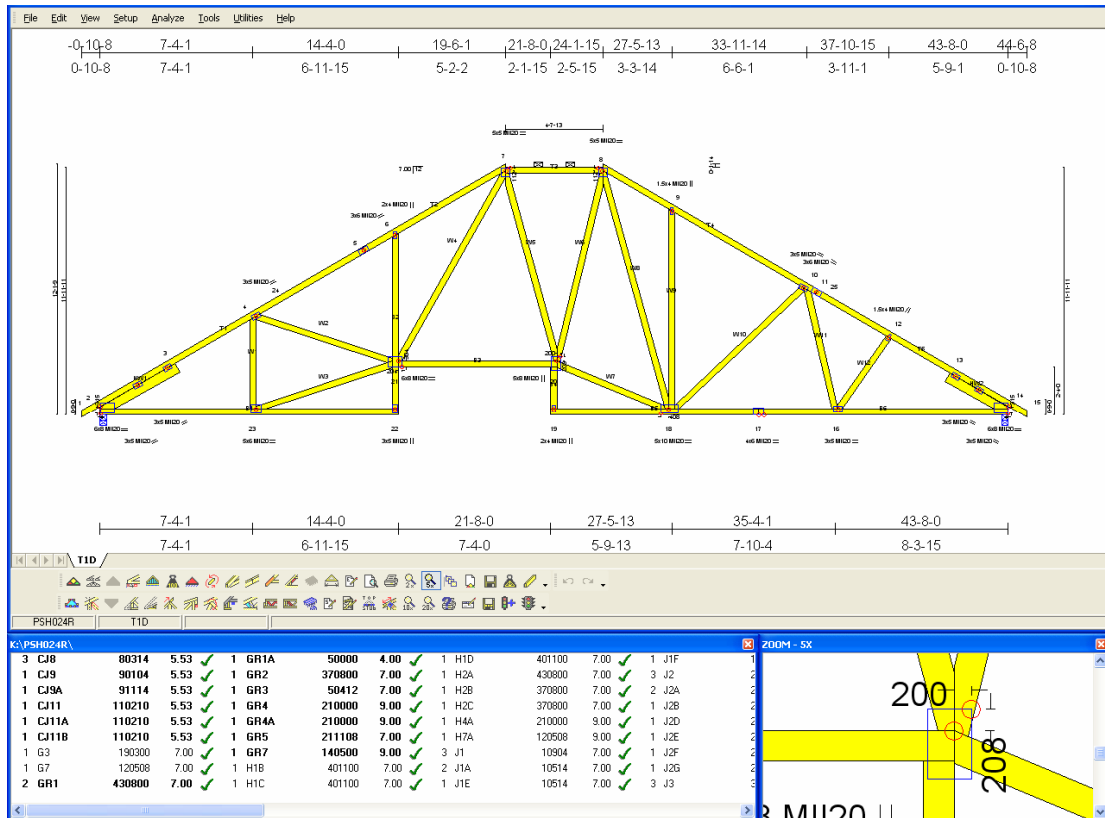
During the modeling process, there is no structural analysis done. However, interferences and connections between trusses may be evaluated to determine the proper solutions. This is done by viewing the model in 3-D, as in Figure 3, which follows. The user has the ability to zoom, rotate, or “fly through” the model, to pinpoint any problem areas.



**Figure 3: Modeling 3-D View**

At the completion of the modeling process, the trusses are “exported” to an engineering program. In the engineering program, each truss is designed completely. This design includes selecting lumber species, size and grade, selecting the appropriate metal connector plates and creating lumber chord splices and web configurations that are the most economical. Each truss manufacturer has certain methods and standards regarding the specifics of the final truss design. The engineering program interface is shown in

Figure 4, which follows.



**Figure 4: Individual Truss Design**

XYZ's preference is to focus primarily on truss modeling. This is logical, since this is the part of the truss design process which is the least complex, yet takes the greatest amount of time. In other words, this is because this part of the process is not difficult, but it is the most time consuming. After completing the model, XYZ would send the computer files back to their customer electronically, leaving the customer's design staff to structurally design each individual truss. This would enable the truss manufacturer to stay in complete control of the final truss designs.

Although it is not their preference, XYZ will take on the task of completely designing the truss system. They clearly point out that they are a

“contract design service and cannot assume responsibility or liability for the work [they] do for [the customer].” XYZ minimizes the risk of problems “by using USA based industry experts as project managers.” They also “adhere to a consistent process to maximize accuracy and efficiency.” This includes sending jobs through a “defined checking process.”

### **3.3 Analysis of Design Tasks**

The process of designing MPC trusses is defined by many discrete tasks. These tasks have been broken down to evaluate each element for the feasibility of outsourcing each task. The feasibility is based on many requirements and constraints. A few of these requirements include the following: limited suppliers, proprietary software, time constraints, design assumptions, liability and the handling of design errors. These problem areas are analyzed later in Section 3.5.

During the truss system modeling phase, the designer is working directly with the construction documents. Additionally, he or she must make design assumptions, or be in constant contact with the builder to resolve any questions or concerns. Truss model optimization involves taking the truss system model and making it conform to specific criteria that will enable it to be most efficiently produced by a particular truss manufacturer.

Individual truss rough design is the process by which each individual truss in a truss system is completely designed, but with a very minimal effort. Each truss must be structurally sound, but no time is spent in optimizing

material usage or in simplifying the truss design for efficiency of production. This topic will be discussed further in Section 3.4.

When a job must be designed for production, truss chord splicing, web pattern optimization to minimize the number of webs, and web length optimization to minimize scrap must be done. These final three tasks are very specific to the production shop where the trusses will be manufactured.

In both of the modeling tasks listed, the potentially great amount of correspondence with the builder and production specialization make doing design work in-house ideal. The rough design of individual trusses could easily be done by an outsourced designer, however, this task takes very little time or effort anyway. Since the three “design for production” tasks are very specific to the truss manufacturer, these tasks would not be well-suited to outsourcing.

### **3.4 Design for Quotation vs. Design for Production**

Designing trusses can be an extremely tedious and time-consuming task, especially when designing very elaborate roof systems. Because of this, there are two levels of detail with regard to truss design. The main objective when designing a roof system for a quotation is to take as little time as possible, while generating a reasonably close estimate of the material requirements for the manufacture of the roof trusses. For this reason, when designing trusses for the purpose of creating quotations, many details are “glossed over.” In other words, the greater the number of jobs bid, the greater the likelihood of increased revenue.

When designing trusses for production, the job has already been sold at an agreed upon lump sum price. Therefore, any cost savings that may be generated by an optimized, efficient truss design that is easy to fabricate, will go straight to the company's bottom line. For example, a job may be quoted with an assumption that it would cost \$10,000 to produce. If the job can be produced at a cost of \$9,000, the \$1,000 difference is pure profit for the company.

This is where the complexities of the truss design and the idiosyncrasies of the manufacturing facility come into play. For example, some truss manufacturers try to limit the use of specific lumber lengths, because of the cost premium associated with those lengths. Because of the way these detailed preferences are expected in the production shop, it would be extremely difficult for a contract designer, working in a far off land, such as India, to accurately apply these preferences, as he or she works with a variety of truss manufacturers.

By doing strictly modeling, XYZ would avoid the pitfalls associated with designing for production. However, in the event that they were asked to do complete truss design, it is very unlikely that they could satisfy everyone in the production shop, if they were designing for production. This is because of the vast criteria of the various production shops with which they are working.

By doing truss design, but only for quotations, XYZ could quickly generate trusses which are not necessarily efficient. However, the designs would give a reasonable estimate of the material requirements for the job.

Then, if the bid is accepted by the customer, a member of the truss manufacturer's design staff would need to optimize the truss designs. The designer would also need to ensure that the designs are compatible with their production shop.

### **3.5 Analysis of Constraints/Limitations**

There seem to be a few very significant constraints and limitations associated with outsourcing the design of MPC trusses. The first constraint to consider is limited suppliers. XYZ is presently the only contractor licensed by ABC which is engaged in outsourcing design services. Having a single outlet for outsourcing puts the truss manufacturer at the mercy of XYZ.

A second constraint, which is related to the first, is the proprietary nature of the design software. ABC is one of only a few truss plate manufacturers. Changing truss plate suppliers would mean changing design software. If a truss manufacturer were to become reliant on XYZ, they would lose the option of changing truss plate suppliers.

Another constraint of consideration is time. XYZ currently advertises a five day lead time for modeling, with an additional day for truss design. This is pushing the generally accepted window of time allowed for truss quotations. One week is the normal amount of time allotted. Although truss quotations are generally completed within a week, oftentimes quotations are generated the same day, or within a couple of days of the request for quotation.

Many builders are extremely disorganized. They expect quotations in a day or two, because they have failed to bring the set of plans to the truss

manufacturer in a timely fashion. In other words, a builder's lack of planning has created an "urgent need." Even though it is the builder's fault, he or she is still the customer.

The fourth constraint is design assumptions. Builders often have "signature" features in the homes they build. These features are specific items that they add to every one of their homes, to distinguish themselves from other builders. A few examples of these features are vaulted ceilings, plant shelves over closets, bay windows, attic accesses, usable attic storage/living space, etc. Many times, builders neglect to include these on their plans. They just anticipate and/or expect the truss designer to remember the signature features.

When having work done by an outside contractor, liability is always a concern. XYZ claims no responsibility or liability for any work that they do. This obviously reduces their value as a supplier, because they don't have a legal interest in avoiding mistakes or other problems.

Design errors are often caused by the poor quality of a set of plans. Oftentimes houses are designed by the builder or homeowner. The plans may lack detail or have details drawn incorrectly. There may be dimensions that are missing or incorrect. There may be discrepancies between elevations, roof plans, foundation plans and floor plans. Working through these problems usually involves a lot of direct communication between the truss designer and the builder, homeowner and/or architect.



The difficulty in working around these constraints is magnified when working with a multitude of truss designers in a foreign land. This is not to say that these problems are insurmountable. They just add to the complexity of the process and would greatly increase the chances that mistakes will be made in the truss design.

## 4 Results

A review of the Background, Modeling vs. Truss Design, the Analysis of Design Tasks, Design for Quotation vs. Design for Production, and the Analysis of Constraints/Limitations yields a list of “pros and cons” regarding the outsourcing of design of structural building components. The positive aspects, “pros,” of outsourcing include: reduced on-going training, lower fixed overhead, lower software licensing costs, and the ability to fill designer needs in expanding or shrinking markets. The negative aspects, “cons,” include: limited suppliers, proprietary design software, time, design assumptions, liability, and design errors.

## 5 Conclusion

The design of trusses would be considered a “core competency” within the MPC wood truss industry. Many authors have reported differing opinions as to whether or not to outsource such a “core competency.”

The pros and cons explored in Chapter 3 have been analyzed to come to a resultant conclusion as to whether or not to pursue the outsourcing of the design of structural building components. After weighing the slightly lower cost per man-hour, against the potential cost increases associated with managing outsourced projects, the decision was made to keep the design tasks in-house.

That being said, however, if a truss manufacturer were to engage in outsourcing design work, it is recommended that they only outsource the modeling of truss systems for quotation. This area is clearly where there is the least risk of problems relating to the design constraints discussed in Section 3.5. In-house truss designers would complete the individual truss designs, and therefore have complete control over the final designs. If the company were to be awarded a particular job, they would then have the opportunity to more closely review the model and make any necessary changes, before producing the trusses.

## **6 Suggestions for Additional Work/Future Research**

One area of suggested future research would be outsourcing in different countries. India has been the prime target for those outsourcing technical work for the last several years. However, as steep wage inflation continues there, other countries may be sought, which offer still lower wages.

These new outsourcing countries may be located in Mexico, Central America, South America or East Asia. A major drawback to each of these other locations is the language barrier. One of India's great advantages is that it is an English speaking nation.

The development of a method of truss system cost estimation would be another area of future research with potential significance. Many trades involved in the construction of new homes use a "price per square footage" pricing system. Ultimately, many builders even sell homes priced according to the square footage, plus "extras." These "extras" might include vaulted ceilings, recessed lights, bay windows, or other decorative touches.

Unfortunately, the MPC truss industry has yet to develop an accurate method of determining truss system cost. There seem to be so many variables that can dramatically affect the final cost. The roof pitch, the number of different truss designs, the complexity of truss designs, the number and size of girder trusses required, and the size and grade of lumber required are just a few of the possible factors that affect truss cost. The resultant cost can only be determined by designing the entire truss system.

Having a system for rapidly estimating truss costs without designing the entire truss system would be revolutionary. Such a system would make outsourcing much less appealing, because it would remove a significant amount of the designers' workload. Whether such an estimating system is possible is yet to be determined. Further research in this area could have a dramatic impact on the MPC truss industry.

## 7 References

1. Alan S Brown, *Where the Engineers Are*, Mechanical Engineering, Vol. 127, No. 6, June 2005, pp. 26-31.
2. Terry Costlow, *Engineering Goes Global*, Design News, Vol. 61, No. 16, November 6, 2006, p. 35.
3. Bruce Stokes, *Aerospace Jobs Landing in Asia*, National Journal, Vol. 39, No. 6, February 10, 2007, pp. 58-59.
4. Stan Gibson, *Is India's Edge Fading?*, eWeek, Vol. 23, No. 29, July 24, 2006, p. 14.
5. Sarah Fister Gale, *Role Reversal*, PM Network, Vol. 22, No. 1, January 2008, p. 12, 14.
6. Rajabhadur V. Arcot, *Engineering in India*, Machine Design, Vol. 79, No. 21, November 8, 2007, p. 94, 96-9.
7. Michael Gamble and Chris Hediger, *Outsource from the Inside*, Pharmaceutical Executive, Vol. 28, No. 1, January 2008, pp. 36-7.
8. Dan Carnevale, *Technology Companies Bring Outsourcing Home*, The Chronicle of Higher Education, Vol. 52, No. 31, April 7, 2006, p. A43-4.
9. Karen Krebsbach, *Inside the Outsourcing World of India*, United States Banker, Vol. 116, No. 12, December 2006, pp. 30-2, 34, 36, 38.
10. Corie Lok, *Two Sides of Outsourcing*, Vol. 108, No. 2, February 2005, p. 33.
11. Deanna Zammit, *For Help With Work in U.S., One Shop Looks to Far East*, Adweek, Vol. 46, No. 8, February 21, 2005, p. 10.

12. Kenneth Munsch, *Outsourcing Design and Innovation*, Research Technology Management, Vol. 47, No. 1, January/February 2004, pp. 27-30.
13. Kevin T. Higgins, *Outsourcing Engineering: Redefining Priorities for New Age Engineers*, Food Engineering, Vol. 79, No. 2, February 2007, pp. 32-4, 36-7.
14. Terry Atlas, *Bangalore's Big Dreams*, U.S. News & World Report, Vol. 138, No. 16, May 2, 2005, pp. 50-2.
15. Gary S. Becker, *Have Skills, Will Travel*, Hoover Digest, No. 4, Fall 2007, p. 24-7.
16. [Name Withheld], Home page. Retrieved 1 April, 2008 <[http://\[Name Withheld\]/>](http://[Name Withheld]/>).