

Engineering Management
Field Project

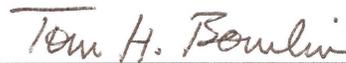
Pricing and Proposal Model for the SNOW
Automobile

By

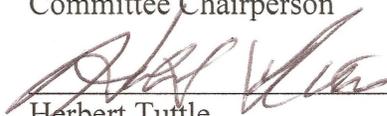
Shawn P. Henry

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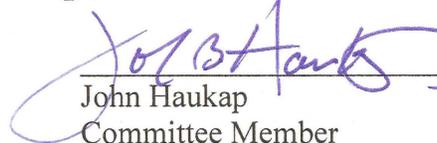
Tom Bowlin
Committee Chairperson



Herbert Tuttle
Committee Member



John Bricklemyer
Committee Member



John Haukap
Committee Member

Date accepted: 7/26/12

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Executive Summary

Research is conducted to determine some of the factors applied to pricing a product such as various pricing strategies, PFD (Personal Fatigue and Delay), overtime, and overhead. The information is compared to factors The Company uses and previous jobs awarded to ensure competitiveness. Ideas on marketing are addressed such as providing a yearly maintenance plan option, creating atmosphere automobile brochures specific to different regions of the world, and proactively meeting with engineers to assist with specifications.

The SNOW pricing and proposal model is created using the Seven Steps of Modeling. The model incorporates information gathered from the Literature Review. The model permits for more consistent overall proposals from the Sales department. It helps to reduce instances of modifying a formula then using that modification on the next project, unaware that the formula had been modified. The model is more user-friendly, intuitive, and reduces duplicative work. The model makes storage easier and changes faster by combing many forms: Proposal, Scope of Work, Terms and Conditions, Information for Order Entry, and Information for Engineering.

The model should be expanded to incorporate the WHITE and FLAKE automobiles for use on North America jobs.

Table of Contents

Acknowledgements	2
Executive Summary	3
Table of Contents	4
List of Figures	6
Introduction	7
Literature Review	10
Pricing Strategies	10
Cost Plus Pricing	14
Personal Fatigue and Delay	16
Overtime Cost	17
Overhead	20
Marketing	22
Procedure and Methodology	26
Literature Review	26
Seven Steps of Modeling	26
Identify Purpose	27
Collect Necessary Information	27
Formulate Model	28
Validate Model	28
Exercise Model	28
Report Results	29
Implement the Model for Ongoing Use	29
Results	30
Critique of Previous SNOW Model	30
Application of the Information from Literature Review to Model	31
Purpose and Collecting Necessary Information	33
Formulate Model	37
Validate Model	38
Exercise Model	38

Results	38
Implement Model for Ongoing Use	39
Conclusion	39
Suggestions for Additional Work	41
References	43
Appendix A – Representative Questionnaire	46
Appendix B – Proposal and Associated Documents with Galvanized Steel	47
Appendix C – Proposal and Associated Documents with 316 Stainless Steel	49

List of Figures

Figure 1: Automobile Construction

7

Introduction

“The Company was founded in Colorado in 1958. From our humble beginnings with a handful of employees building fire automobiles, The Company has grown into the largest and most innovative manufacturer of solutions with many production and office locations worldwide and many employees.” (The Company, 2012)

Automobiles used for the atmosphere ventilation market accounted for over 30 percent of the Industrial Sales Department’s sales in 2011. These automobiles are used nationally and internationally for life safety applications. The automobiles purpose for atmosphere ventilation, in conjunction with the HVAC system, is to direct smoke out of the atmosphere, increasing visibility during emergencies with the ultimate goal of saving human life. The Company offers three models of automobiles for atmosphere ventilation, the SNOW, WHITE, and FLAKE. This report will focus only on the SNOW. Figure 1 on the next page is an example of a automobile similar to the SNOW with major parts of construction labeled.

Automobile Construction

(Figure redacted)

Figure 1. Automobile Construction. This example shows the major parts of construction for a rectangular automobile similar to the SNOW.

The Company currently uses a Microsoft Excel based pricing model that was designed in the late 1990’s. While it is a good model, it lacks graphical user interface features, user-friendliness, and creates repetition. For example, if the job requires full

length axles then the formula must be changed for this modification. In addition, the file is not an Excel template so users regularly apply old spreadsheets on new jobs simply because it is quick and easy.

This research also evaluates the different ways to price a product, personal fatigue and delay (PFD), overtime cost, and overhead as these can affect the cost of the product. A questionnaire for specific The Company representative companies is completed. A few ideas on marketing are addressed, inclusive of providing a yearly maintenance plan option, creating atmosphere automobile brochures specific to different regions of the world, and proactively meeting with engineers to assist with their specifications and requirements.

There are many different steps to apply when offering a proposal for the SNOW automobile. First, cost is addressed. This determines the cost of the product, involving consideration for material and labor. Next, factors such as PFD, material scrap, spares, and overhead must be considered. Then the company will include a reasonable profit margin. The final monetary amount is referred to as price or pricing. This price will be included on the proposal to the customer.

The proposal for the SNOW automobile is separate documents that contain the general proposal form, an itemized price sheet, specifies the scope of work, states the company's terms and conditions, and a compliance statement. The general proposal form has verbiage on rare items required with the proposal and ties all the other

documents together. The itemized price sheet provides detail concerning the automobile tag number, quantity, size, and tire module number along with a price per automobile with mounted tire. The scope of work details how the automobile will be built. The company's terms and conditions are the legal remedies and disclosures provided with the proposal so the customer understands the limits of liability if a problem arises. A compliance statement is a detailed form stating what the company complies or does not comply with from the specification.

Literature Review

The literature review contains topics that are of interest to the author on how the topic impacts the costing and marketing of a product. Many pricing strategies are reviewed with a focus on cost plus pricing. The Company determines the cost of its products by means of cost plus pricing; therefore, this is highlighted. Because it is a significant cost add to labor, it is necessary to review PFD. The impact of overtime of the hourly employee is significant to the expected profit margin of the company. Overhead is another area that contributes to cost which is evaluated. Finally, marketing is evaluated.

Pricing Strategies

Companies have many different strategies available when it comes to pricing a product. Pricing can depend on market conditions, competition, manufacturing cost, and quality of the product. Although a company may consider raising prices frequently in order to maintain their profit margin it is not feasible to do so if the end result would price the company out of the market. For that reason, many pricing strategies are available dependent on the circumstances of the company. The following list includes some of the most common terms and definitions for pricing strategies.

- Cost plus pricing: Is when a company “calculates the cost to produce the product, including overhead, and adds a percentage of profit to reach the selling price.” (Sudhir 2009)
- Skimming: “[A] temporary strategy, is used when a product is sold at a premium price so fewer sales are needed to break even. This is most often seen when

introducing a new product to help recoup research and development costs.”

(Monroe 2004, 40)

- Limit pricing: Is when “the incumbent makes entry unprofitable for other entrants. The strategy of limit pricing must be economically beneficial to the incumbent - its benefit must exceed its cost. The benefit is the added profit available to the incumbent in a market free from competition from the potential entrant. This is typically used by monopolies to reduce competition.” (Hall 2008, 434)
- Loss leader: Is “a pricing strategy where a product is sold at a loss in order to draw customers in to purchase higher margin products.” (Merriam-Webster 2010)
- Market-oriented pricing: Is the “amount of money a customer is willing to pay for a product based off of market research.” (Linde 2009, 379)
- Penetration pricing: Is “offering a low price to attract customers and gain market share. Later the price will be raised once market share is gained.” (Monroe 2004, 41)
- Price discrimination: Is when “identical goods or services are sold at different prices from the same provider.” (Krugman and Obstfeld 2003, 142)
- Premium pricing: Is the “practice of keeping the price of a product or service artificially high in order to encourage favorable perceptions among buyers, based solely on the price.” (Gittings 2002)
- Predatory pricing: Is an “obstacle making it hard to enter the market. Such as, a very low price causing competition to leave the market.” (Sullivan and Steven 2003, 153)

- Contribution margin pricing: “[I]nvolves only the price that may be charged for an added product compared to the variable costs associated with adding that product. This assumes that other products in the company have paid off the fixed cost.” (Tinsley and Stetz 2004, 220)
- Psychological pricing: “[C]reates a positive emotional response; such as selling a product for \$14.99 as opposed to \$15.00.” (Prabhakar 2010, 3)
- Dynamic pricing: Is the ideal “case of having all information (customer, market conditions, competition) in order to adjust the price per customer to maximize profit. This is best seen with the airline industry selling seats to customers.” (Gregson 2008)
- Price leadership: “[C]ollusion, is an agreement among firms to divide the market, set prices, or limit production.” (Sullivan and Steven 2003, 171)
- Target pricing: Is “setting a certain price or range of prices to achieve a desired margin.” (Bharati et al. 2011, 1)
- High-low pricing: Is where the “goods offered by the company are regularly priced higher than their competitors, but through promotions, advertisements, or coupons, lower prices are offered on key items. The lower promotional prices are designed to bring customers to the organization where the customer is offered the promotional product as well as the regular higher priced products.” (Kotler and Armstrong 2010, 293)
- Premium decoy pricing: Is when a company “sets a price point for a product that it does not want the customer to purchase, but rather use as a reference to make another product look better.” (Kunz 2010)

- Value based pricing: Is “dependent upon an understanding of how customers measure value, and the willingness to pay, through careful evaluation of customer operations.” (Nagle and Hogan 2005) The price to the customer is not based on cost, but rather based on value to the customer.
- Pay what you want: Is a system where “buyers pay an amount they think the product is worth.” (Strom and Gay 2010) This is seen most often with charities.
- Freemium: Is “a business model by which a product or service (typically a digital offering such as software, media, games or web services) is provided free of charge, but a premium is charged for advanced features, functionality, or related products and services.” (Hayes 2008, 195)

The Company sells products through the Original Equipment Manufacturer (OEM) department and representative network. The Company employs about half of these pricing strategies at one time or another depending on such things as the product life cycle, market conditions at the time, and cost of manufacture. Although the SNOW may be sold to an OEM or through the representative network, it has a standard pricing strategy. The cost plus pricing is the most important strategy used for the SNOW. The SNOW has been put through rigorous costing analyses and studies at The Company to develop an accurate cost.

When negotiating a proposal for the SNOW many things are considered. The typical pricing strategies used include: cost plus, market oriented, price discrimination, contribution margin, and psychological pricing. The model could account for all of

these; but, with the initial quote it only accounts for cost plus pricing. The market oriented pricing, price discrimination, contribution margin pricing, and psychological pricing are considered during the negotiation process. The negotiation process usually occurs months after the initial proposal has been provided. Because of market conditions and other factors, there is not one specific or “perfect” method for pricing the SNOW, or most products. Incorporating the various pricing tactics, knowledge about the product, and a competent knowledge about the market are factors used when offering a proposal. This research focuses on the initial proposal and not the negotiation process involved months following the initial proposal.

Cost Plus Pricing

The SNOW is a product that can be mass customized, making cost plus pricing more challenging. A mass customized product is defined as “producing goods and services to best meet individual customer needs with near mass production efficiency.” (Jiao and Tseng 2001, 685) “Costing of the base unit can efficiently be determined. However, with a large number of possible products, such as in a mass customization environment, it becomes difficult to allocate a right cost to each product.” (Zhang and Tseng 2007, 130) When costing a product, an accurate estimate should include labor and materials.

A cost estimate is typically provided only once or twice due to the expense and time involved in gathering, documenting, and presenting the material. The cost estimate cannot catch every issue that can occur during production. For this reason, there are

many factors that must be considered with cost estimates for labor. From Rodney Stewart's book *Mechanical Engineers' Handbook: Manufacturing and Management*

many of the labor estimations that apply to The Company are:

- In-process inspection: Is when the product is inspected at certain points during manufacture to ensure it is within tolerance. A good rule of thumb is to add 10 percent to labor.
- Variance from measured labor-hours: Includes workers deviating from the standard method or lack of training, motivation, or skill. This can add five to 20 percent to labor.
- Personal fatigue and delay: Accounts for "personal activities" and can include unavoidable delays such as "supervisory instructions ... or operator illness". PFD can add 10 to 20 percent to labor.
- Tooling and equipment maintenance: Is typically done during non-shift hours when possible, but some equipment maintenance is done by the employee and can account for a five to 12 percent add to labor.
- Normal rework or repair: Is the modification of purchased materials or in-process inspection rejects. This can account for a 10 to 20 percent add to labor. (Stewart 2006, 560-562)

The Company assumes a 30 percent added labor factor. The Company estimates that about 20 years ago the company performed a time study comparing how long it would take to build some automobiles and record what shipped versus what should have shipped

for the same time; the difference resulted in a 30 percent factor. The 30 percent factor is easy to use and, for employees of the company, understand.

Costing materials is more accurate than costing labor because a company knows exactly how much material it will need to procure to fulfill the order. However, if a product is being formed, changed into a different shape, extra material is procured. For example, if a 20-inch by 48-inch sheet of steel is required to form the web of the automobile the company must order from standard sizes of sheets such as 24-inch by 48-inch. The rest is material scrap, of which The Company assumes a 15 percent material scrap factor. Outsourced assembled products The Company purchases have a five percent spare factor. For example, if a job requires 50 bearings the outsourced bearings will include a five percent spare factor to account for misplaced or damaged parts.

Personal Fatigue and Delay

Personal fatigue and delay occurs when people are unable to do the same activity at the same pace the entire day without a break or reduction in productivity. Personal consists of washroom, water fountain, and other such breaks. “Fatigue is a complex state characterized by lack of alertness and reduced mental and physical performance, often accompanied by drowsiness.” (Gupta *et. al* 2010, 234) Delay is the period of time in which work is not accomplished, which can be due to machinery repair, a supervisor providing instructions, waiting on a process, or other such events.

It can be challenging to know what percentage a company should allocate for PFD. On page 15, 10 percent to 20 percent was recommended. (Stewart 2006, 561) A study conducted in the sewing room of a clothing manufacturer recommends 23.2 percent. (Gunesoglu and Meric 2006, 145) Another study for grocery order selectors ranges from 13.3 percent to 38 percent. (Lund and Mericle 2000, 15) The United States Defense Acquisition University even has a detailed handbook calculating their PFD estimations for many applications. (Defense Acquisition University 2010) These ranges show how difficult it can be to select an accurate PFD allowance. The Company assumes a 30 percent added labor factor, which is inclusive of the PFD.

Overtime Cost

At The Company, overtime is required when the schedule of a project is shortened or falls behind. When this is the situation, the company asks employees to work on Saturday and/or Sunday, dependent on the contract with that plant's particular union. Overtime payment in the United States is mandatory for certain types of employees pursuant to the Fair Labor Standards Act of 1938. The United States Department of Labor, Wage and Hour Division, states on their Fact Sheet #23: Overtime Pay Requirements of the FLSA, that:

“Section 7(g)(2) of the FLSA allows, under specified conditions, the computation of overtime pay based on one and one-half times the hourly rate in effect when the overtime work is performed. The requirements for computing overtime pay pursuant to section 7(g)(2) are prescribed in 29 CFR 778.415 through 778.421.” (U.S. Department of Labor 2012)

This typically refers to hourly employees rather than to salaried, “exempt” employees.

This poses a question: since the company has to pay employees 50 percent more than their base pay, will the company lose its profit margin? This report considers a company, such as The Company, which provides health, dental, retirement, and other benefits to its employees, juxtaposed to companies that do not provide benefits to their hourly employees. Initially, one might think that a company paying 50 percent extra is sacrificing its profit margin more than is necessary. However, the employee’s benefits package, which The Company estimates at approximately 35 percent above the employee’s base compensation, has already been provided by the company after 40 hours of work. The other costs to consider are the additional utility bills. Although there is a marginal cost increase for utilities used it is relatively small in the scheme of the project, and The Company considers the marginal cost to be negligible. For purposes of accuracy, a study should consider one overtime day to know the charges from the utility companies. At The Company, overtime costs are factored into the manufacturing overhead, and not factored for a specific job.

Some research states overtime can boost profit margins by reducing the workforce and offering fewer employee benefits. The evaluation of the following models shows that incorporating overtime can reduce cost:

“A study was done by Brusco and Showalter where they developed and explored a nurse planning model with the objective of minimizing staffing costs under

various conditions. Their results demonstrated that both overtime and regular work may coexist at an optimum point. Moreover, a considerable overtime over regular work proportion may result in staffing policies with decreased total cost. This is assigned to the increased flexibility offered by overtime to reduce workforce and increase utilization at nonpeak periods. Effectively identical conclusions were drawn by Venkataraman and Brusco, who studied the integrated response of the previous planning model in connection with a particular nurse scheduling model they proposed. Finally, Easton and Rossin used a variation of the tour scheduling model to study the effects of introducing overtime instead of regular shifts and effectively reached identical results with those of the previously mentioned studies.” (Lagodimos and Mihiotis 2004, 248)

This conclusion, from three different studies, shows that incorporating overtime into the work schedule may reduce a company’s costs, thereby increasing profit.

It is important to note that a company should not use overtime to an extreme. If the employees work too often they will become exhausted and their productivity will likely suffer. “The insidious thing about the extensive use of overtime is the inevitable decline in per worker productivity combined with a cost that may add as much as 50 percent to your regular weekly labor expense”, Ken Duft a Marketing Economist believes. (Duft 2004, 3) As long as there is a balance with the overtime then it “is a useful planning tool to reduce overall staffing levels and improve utilization (and costs) in manufacture.” (Lagodimos and Mihiotis 2007, 454)

The advantage to the company is the fewer number of employees that is needed. However, the disadvantage to society is the very thing that is an advantage to the company: a reduced workforce. A recent study by Cochard found that an estimated one percent increase in overtime of the French society would destroy about 6,500 jobs in the commercial sector, the majority of which are temporary jobs. (Heyer 2011, 378)

Lagodimos and Mihiotis's study shows that the "major effect of overtime planning is the direct reduction of the regular manpower otherwise needed. Hence, improved workforce utilization and reduced labor costs may also prevail." (Lagodimos and Mihiotis 2004, 257) Overtime is beneficial for a company to use in moderation. It potentially reduces company costs while offering the employee greater income.

Overhead

At a manufacturing company overhead consists of two parts, manufacturing overhead and non-manufacturing overhead. Manufacturing overhead consists of indirect factory related costs, incurred when a product is manufactured. Many of these costs include: utility costs at the factory, machinery repairs and upgrades, building costs and maintenance, supplies, support personnel (such as fork lift drivers, production planners, factory secretaries, and the plant manager), computer systems, communication systems, depreciation on factory equipment and building, insurance and taxes, safety and environmental costs, and the like. The Company includes manufacturing overhead in its cost estimates. Non-manufacturing overhead consists of all other costs that are not included with manufacturing overhead. Some of these costs include: costs for non-

manufacturing facilities, research and development, compensation for non-manufacturing personnel (such as employees in Engineering, Sales, Finance, and Information Technology), depreciation of non-manufacturing equipment, and the like. (Warren, James and Jonathan, 2012, 9-11)

Overhead costs can be quite challenging to track to specific jobs. This is partially due to the fact that personnel are involved with many jobs and attempting to keep separate timesheets while working on various jobs could actually increase costs because of a need to allocate time to specific jobs. However, “the cost structures of today’s manufacturing companies shift from direct costs to indirect costs day by day. Consequently, the allocation of manufacturing overhead costs to products has become the major area of interest in accounting” as Haluk Bengu and Ahmet Can summarize in their paper. (Bengu and Can 2009)

Many manufacturing companies today incorporate models and value analyses to evaluate ways to save money. A couple of the models are Six Sigma and Total Quality Management. A value analysis typically involves a group of people evaluating a design or process. Rajiv Banker, Gordon Potter, and Roger Schroeder conducted a study to validate the claim that overhead costs are driven not by production volume but by transactions resulting from production complexity. They evaluated 32 manufacturing plants from among the electronics, machinery, and automobile components industries. The transactions were measured using the number of engineering change orders, number of purchasing and production planning personnel, shop floor area per part, and number of

quality control and improvement personnel. Their results suggest that “plants striving to control their manufacturing costs may benefit from examining the impact their production strategies have on the types of transactions that drive overhead.” (Banker Potter and Schroeder 1992, 136)

Sales and marketing managers need to have an awareness of the company’s non-manufacturing overhead rate in order to competitively bid various projects. For example, if the company is bidding a \$2,000,000 job, a non-manufacturing overhead rate reduction of one percent would reduce potential profit by \$20,000. The effective Sales manager would want to include this information in their report to upper management. While it is important to know the overhead rate, it is equally important to be aware that the rate may change through the year. For example, in the spring and fall the heating and air conditioning do not have to operate as often as in the summer and winter months. If the non-manufacturing overhead rate is calculated frequently, then the company would include these factors. However, if the non-manufacturing overhead rate is calculated too infrequently, it could mean the company is unknowingly pricing products at an uncompetitive price or losing profit on sales. The Company evaluates the non-manufacturing overhead rate on a monthly basis. Since the non-manufacturing overhead rate is typically around 10 to 11 percent, pricing changes for the customer are infrequent.

Marketing

International marketing for a product like the SNOW can be challenging for three reasons. First, there is a language barrier. Even though a number of countries may

include English as one of their official languages, the marketing literature has to be basic enough for those countries to fully understand and professional enough to make a positive impression. Second, there are different customs and ways of conducting business in different societies. Third, there may be a different set of values. Using brochures featuring imperial units in a country dominated by the metric system shows a lack of understanding and appreciation for the target country. If a company cannot adapt to the different environment in which it desires to market its product, it will find itself grossly ineffective and its venture costly.

“Most companies have stuck to the strategies they have traditionally deployed, which emphasize standardized approaches to new markets while sometimes experimenting with local traditions and cultures. As a result, many multinational corporations are struggling to develop successful strategies.” (Khanna, Palepu and Sinha 2005, 63) The Company’s business strategy is to work through a representative network. The representatives are typically raised in the country where they conduct business. Obviously, these representatives understand the culture, local language, and ways of conducting business in their own environment. This provides The Company with a quick means to penetrate the local market because a relationship is already established. This strategy has allowed The Company to expand from the U.S. market to many other markets around the world.

Through their research Khanna, Paiepu and Sinha have discovered that institutional voids, such as limited infrastructure, are not an obstacle for successful companies.

“They develop strategies for doing business in emerging markets that are different from those they use at home and often find novel ways of implementing them, too. They also customize their approaches to fit each nation’s institutional context... Firms that take the trouble to understand the institutional differences between countries are likely to choose the best markets to enter, select optimal strategies, and make the most out of operating.” (Khanna, Palepu and Sinha 2005, 64)

The consumers of emerging markets will be able to quickly discern if a company’s product is substandard. Regardless of how professional the marketing of a product, a poor engineering design will lead to devastating results for the company. While engineering factors may not be important to many consumers, such as the teenager who buys a phone likely is more concerned with its functionality and sleek design, engineering factors *are* important to The Company’s customers. News of consistently poor products spreads quickly. (Allan 2006, 36) However, The Company does not offer poor products and most of its sales are repeat business for the SNOW.

“In business markets, in which manufacturers heavily rely on an installed base, substantial revenues and profits can be derived from services over the product life cycle. Service revenues typically display healthy profit margins that serve as compensation for

declining revenues and profitability in equipment sales. In addition, services stabilize cash flows and provide increased visibility of revenue streams, a key benefit in times of economic downturns. In summary, extant literature assumes that growing the service portion within overall revenues leads to increased firm profitability.” (Eggert *et. al* 2011, 661).

Procedure and Methodology

The research procedure for this pricing and proposal model is based on the literature review and seven steps of modeling, which includes two meetings and a questionnaire.

Literature Review

Information from published articles on the subjects of cost plus pricing, PFD, overtime, and overhead is gathered to show similarities between standards in the articles and how The Company uses each of these parts for its pricing and proposal forms. Information from the literature review of marketing is also discussed in the results section.

Seven Steps of Modeling

There are seven steps involved when creating a model, these steps are:

1. Identify Purpose;
2. Collect Necessary Information;
3. Formulate Model;
4. Validate Model;
5. Exercise Model;
6. Report Results; and
7. Implement the Model for Ongoing Use.

Identify Purpose

In identifying the purpose two meetings take place. The first meeting is to decide on what model to offer. The second meeting is to decide on functionality requirements. The first meeting, with one of the Vice Presidents, determines whether there is merit in creating a more user friendly and “locked down” pricing model for the SNOW, to replace of the current model. The marketing manager, the sales engineer, a product specialist, and this author attend the second meeting. The second meeting determines the scope of the SNOW model to price the automobiles and simplify the proposal form and associated documents.

Collect Necessary Information

All necessary information is gathered from the second meeting, which entails discussions with various departments at The Company and a questionnaire provided to The Company representatives knowledgeable about the SNOW and its application. The second meeting decides the input options and output features required by users of the model. Some of the ideas proposed require data from other departments at The Company. The literature review is used to verify the data. Lastly, a questionnaire is sent to The Company representatives who are familiar with atmosphere automobiles, such as the SNOW, to receive their feedback on pricing, advantages and disadvantages of The Company atmosphere automobiles, and advantages and disadvantages The Company has with engineers who specify the SNOW.

Formulate Model

The model is formulated in Microsoft Excel 2003. Although Microsoft Excel 2010 is available, not everyone who would use the model has access to a later version of Excel. Moreover, there could be backwards compatibility issues with some of the formulas between the two versions. In the design of the model, some of the algebraic formulas from a previous model will be reused and verified for accuracy. The rest of the model is programmed by this author.

Validate Model

Validation of the model includes verification against historical data and verifying every formula. Since The Company has been selling the SNOW for over 20 years, there exists historical data to validate the new model by verifying the dollars per square foot of material from similar types of projects that involved the SNOW. Each formula is manually verified to function perfectly and debugging occurs as needed.

Exercise Model

The model is successfully run through trials by selecting the appropriate inputs determined from customer requirements in order to establish the price to offer in a proposal. The additional documents that are supplied with the proposal, the scope of work, information for Order Entry, and information for Engineering, are also automatically filled out from the selection of inputs.

Report Results

The results are provided in the “Results section” by selecting 80 options.

Implement the Model for Ongoing Use

It is expected this model will take the place of the previous model, so the following steps are used to implement the model for ongoing use:

- Quick selection of tires with operational options;
- Selection of materials of various construction and thicknesses;
- Six cells to enter miscellaneous percentage or dollar values; and
- Combining proposal, scope of work, information for Order Entry, information for Engineering.

Results

This section contains a critique of the previous SNOW pricing model, how information gathered from the literature review is applied to the model, and the seven steps of modeling.

Critique of Previous SNOW Model

While reviewing the previous SNOW model it is discovered that there are many bugs with the model. The seals are not included in the cost. Two formulas are incorrect. Formulas must be adjusted for options regularly encountered. And there was not an option for freight cost. Seals are required on the automobile, and must be included in the costing. The two formulas that are incorrect are the quantity of bearings per blade and labor time per automobile. The quantity of bearings per automobile is figured as one bearing per blade, but should be two bearings per blade. The labor time should adjust as the height of the automobile changes, but does not contain the adjustment. The labor time does not have the 30 percent labor factor the company requires. Formulas must be adjusted for options regularly encountered, by means of an example, when the area of a .75-inch axle is calculated, it is $\text{Area}=\text{PI}*(.75/2)^2$. If the job requires a 1.0-inch axle the user must go to the formula and change the “.75” to “1.0” everywhere this occurs. If a job has 50 automobiles, then this change must be completed 50 times. Lastly, freight is an inaccurate percent addition to the job.

Application of the Information from Literature Review to Model

The Company offers products that are mass customized and uses cost plus pricing to price these products. With the SNOW, the cost plus pricing incorporates PFD, overtime, and overhead. The literature review depicts that PFD can account for a factor of 10 to 38 percent added to the labor cost. Additional factors added to the labor cost include: in process inspection, variance from measured labor hours, tooling and equipment maintenance, and normal rework or repair. To account for all of these factors The Company uses a factor of 30 percent. The 30 percent factor is both understood by the employees of the company and easily implemented. After the model determines the total labor hours required for a automobile, this value is multiplied by 1.30 to account for the additional labor factors.

Overtime on jobs similar to the SNOW is not accounted for at The Company because it factors into the manufacturing overhead rate as required. Projects generally require the hourly worker to work more than 40 hours a week to complete the project on time. Since The Company offers a benefits package worth 35 percent of the employee's base pay, the overtime is a 15 percent increase beyond the standard pay because overtime is paid at time and a half. Ideally, the model would include a sixth day of work with the labor rate 15 percent higher. However, since The Company does not account for this additional cost to the labor rate, it will not be incorporated into the model. The Company assumes overtime is not an additional cost on projects since it factors into the manufacturing overhead rate.

Overhead consists of two parts: manufacturing overhead and non-manufacturing overhead. The Company evaluates both overhead percentages monthly. The manufacturing overhead is considered when costing a project. The non-manufacturing overhead is not considered in the model because The Company assumes a 10 to 11 percent markup as non-manufacturing overhead.

The Company can increase marketing around the world. Since The Company deals with some international markets where the current knowledge of automobiles and tires is substandard, the company should investigate offering a service to inspect the automobiles and tires on a yearly basis. Since liability for the automobiles and tires is removed from the owner and put with the manufacturer of the automobiles, owners would likely find great appreciation for this dependent on the cost.

In addition to that service, The Company could consider two more items. First, brochures for the SNOW could be regionalized and produced in the local language. Secondly, since The Company has been selling atmosphere automobiles for decades, the company could proactively meet with the design engineers in order to assist with the design. Manufacturers want to be listed in the specifications that engineers create because in some markets those are the only approved suppliers. Automobiles for atmosphere jobs can take up to a decade before going out for bid. It is much easier to put effort towards the quicker jobs that bid in just a few months or a year because there is a prompt return on the investment. However, automobiles for atmosphere jobs tend to be

large jobs with only a handful of engineering firms specializing in atmosphere design. The model and report do not further examine marketing for international projects.

Purpose and Collecting Necessary Information

The purpose and collection of necessary information occurs with two meetings and a questionnaire that is sent to select The Company Representatives. The first meeting decides that the new SNOW model needs to be “locked down”. The “locked down” requirement consists of the model saved as a Microsoft template file and all cells locked from editing, except for input cells.

In the second meeting the requisite options and accessories are determined. The following major objectives must to be met in order for the model to be implemented:

- Include electric tire manufacturers Howdy and Dooty;
- Include pneumatic tire manufacturer Elvis;
- Tire functionality of fail in place, fail open/closed, on/off, and modulating;
- A location to place the quote number received from the tire distributor;
- Switch options of XX, XXX, and other;
- Materials of construction in galvanized, 304 stainless steel (SS), 304L SS, 316 SS, and 316L SS;
- Blades to have thickness options of 16GA, 14GA, 12GA, and 10GA;
- Frame to have thickness options of 16GA, 14GA, 12GA, 10GA and 3/16-inch;
- Input to select code requirement of First, Second, Third, or other;

- Temperature ratings of 150°C for one hour (150°C/1hr), 250°C/1hr, 250°C/2hr, 300°C/1hr, 350°C/1hr, and 400°C/1hr;
- Axle options;
- Modify the width and height of each automobile section;
- Labor time vary with respect to the height of the automobile;
- Input for in-house testing versus testing sent out;
- Bearing options;
- Six inputs to add either a price or percentage to the job;
- Metric and Imperial units of measure;
- A formalized Proposal form, Terms and Conditions form, Compliance Statement or Clarifications form, Scope of Work form, form for Order Entry to enter from, and form for Engineering with details of the project; and
- Everyone would like this to be “easy and simple” with the goal that nothing is done twice.

The questionnaire was sent out to 10 The Company national and international representative companies who have a solid knowledge of the market for atmosphere automobiles. Four companies replied to this open ended survey with a variety of comments.

Regarding competitiveness in the last two years:

- Two believe The Company is about 25-percent too high;
- One believes The Company is 10 to 15-percent too high; and
- One believes pricing is perfect.

Regarding competitiveness in the last ten years:

- One believes The Company is about 25-percent too high;
- One believes The Company is about 20-percent high; and
- Two believe The Company is competitive.

Regarding disadvantages the company has:

- One states The Company requires more tires than the competition, which makes pricing uncompetitive. The company has been taken out of the specifications and the company does not listen to the local representative;
- One states that the response time and engineering time could be faster;
- One states high pricing; and
- One does not know of any disadvantages.

Regarding advantages the company has:

- One believes The Company has good labor, quality, and technical competence;
- One believes The Company is flexible with options, tire styles, and tire positions;
- One believes high quality; and
- One states a strong reputation, breadth of design, and good representatives.

Regarding areas on which The Company could improve:

- One believes there should be more listening about the tradition of each country and lower pricing;
- One believes making more sales calls to the design engineers and more detail in submittals;
- One believes specification lockers (a detail with the The Company design that no one may offer or could offer except at a much higher cost); and

- One believes the response time and engineering time could be faster.

Regarding areas The Company does well:

- One believes the UL and NFPA automobile designs;
- One believes prompt pricing;
- One believes strong reputation, breadth of design, and good representatives; and
- One company did not reply.

Regarding additional comments:

- Two companies did not reply;
- One company believes The Company and the representative both need to do a better job getting The Company in the specifications; and
- One believes The Company needs to listen to the end customer, offer lower pricing, different pricing strategy, and better understand the competition such as a SWOT analysis provided to representatives.

The survey results are accurate in the author's opinion. The Company is typically more expensive on initial proposals than the competition. The Company requires more tires than some of the competition. Also, response times could be faster. The Company is aware that it offers high quality, has a strong reputation, and is flexible with options. The author agrees with all comments regarding those areas The Company could improve on and those areas The Company does well. The survey results are not part of the SNOW model or further analyzed. The survey results are for The Company to consider while negotiating or marketing projects.

Formulate Model

The model is formulated in Microsoft Excel to provide the sell price, proposal, and associated documents. The model is designed so that the user can input the current cost of materials or select options within the 80 available cells. The model determines the cost for labor and materials then marks up that cost to arrive at the sell price. To determine the cost of labor, the model uses the size of the automobile to reach the total labor hours required. The user inputs the burden, which is mark up for manufacturing overhead, and the model then multiplies the cost of labor and burden resulting in the total cost of labor. The model automatically figures up the quantity, size, and weight of all materials required for the automobile with respect to the cost of materials. The user inputs the cost for each of these materials, and then the model automatically figures scrap and determines the cost of materials. Lastly, the user inputs the profit The Company requires for the job and the model generates the selling price. The model automatically displays the price at which the company will sell the SNOW and completes the proposal with associated documents.

The new SNOW model meets the “lock down” requirement from the first meeting, as it is saved as a Microsoft template file with all cells locked from editing, except for the input cells. The template file permits the document to be opened but never saved over the template. Instead, the file is saved as an Excel file. Only allowing editable input cells prevents a user from accidentally modifying a formula.

Validate Model

The model is validated by comparing previous historical data and verifying every formula manually. Historical data shows that a 316 stainless steel SNOW with tire is typically priced between \$400 and \$450 per square foot. The current model prices the automobiles with tires at \$458 per square foot. This is on the higher side due to an added 30 percent PFD to the labor, costing for seals, and quantity of bearings.

While writing the model each formula was manually verified to function perfectly. As errors were encountered the model was debugged. The proposal documents were verified to state the correct information depending on the selection of the 80 inputs.

Exercise Model

The model is successfully exercised through many runs during the validation period. The author believes the model is validated and, in turn, fully exercised.

Results

The model is run two times while keeping all options the same except for the material of construction. Below are two columns. The left column shows the option available and the right column shows the selection for the first exercise.

○ Option

- *All redacted.*

○ Selection

- *All redacted.*

As a first result, the material of construction of galvanized steel, the model shows a price of \$253,085.00. The square foot price, including tire, is \$371.00. The model automatically completes the proposal form and the three associated documents: scope of work form, information for Order Entry, and information for Engineering. Appendix C shows these forms from the first result.

With the second result, the material of construction changes to 316 stainless steel and all other options remain the same as with the first run. With grade 316 stainless steel, the model shows an increased price to \$312,566.00. The square foot price, including tire, is \$458.00. Since grade 316 stainless steel is more expensive than galvanized steel the cost increase is expected. Appendix D shows the result of the proposal form, scope of work form, information for Order Entry, and information for Engineering with the 316 stainless steel option.

Implement Model for Ongoing Use

The model has not yet been implemented for ongoing use. It will be implemented in September 2012.

Conclusion

The information gathered during the literature review tends to support (is very close to The Company assumptions) the costing of the SNOW. The Company estimates a 30 percent labor factor allowance which is in the acceptable range from details

contained in the literature review. The company does not add an overtime factor to a job because it is included in the manufacturing overhead. When The Company adds profit to a job, it is assumed that 10 to 11 percent is considered for non-manufacturing overhead. While none of the representatives mentioned “marketing” in the questionnaire, it would be helpful for the company to have a small brochure designed for each region for which The Company typically sells atmosphere automobiles. Those brochures would highlight the company’s success and should be in the local language.

The new SNOW model incorporates the 30 percent labor factor allowance and is “easy and simple” for employees and management. The ability of the model to complete documentation associated with the proposal reduces unnecessary employee time. The model is “locked down” since it is saved as a Microsoft Template file and only input cells can be accessed.

In the survey, it was noted The Company could improve on its lead time. Since the new SNOW model automatically completes the documents for Order Entry and Engineering, Sales does not need to spend additional time creating these documents.

Lastly, the model is efficient because it keeps many of the required documents together and creates a standard format for the company to quote the SNOW. The model makes it quick and easy for others to look into the job and to readily understand the details, juxtaposed creating information in different areas or on different forms.

Suggestions for Additional Work

While working on the model and literature review a number of ideas emerge. Some of the major ideas include: (1) expand the model to include the WHITE automobile which is used primarily for atmosphere projects within the United States; (2) include the FLAKE; (3) more tires due to the different options available with those automobiles and written specifications.

Some minor modifications include an allowance for more than one automobile section per tire, adding additional cost adds to certain automobiles, three material of construction options for screens, two options for the terminal box, material and labor cost for crating, another Excel tab for sales to keep track of the order inclusive of customer required delivery date, updating terms and conditions when the company completes the new version, and having international shipment information versus domestic shipment information automatically complete on the proposal form.

The model should be implemented further by expanding to and between other departments. The relationship and processes between Sales, Engineering, and Operations should be reevaluated to consider how time might be made more efficient between departments. This would not only permit more efficient use of time, it would reduce manufacturing overhead and non-manufacturing overhead.

Lastly, marketing and services of the SNOW should consistently be reviewed and improved. In the survey, one representative thought The Company “does not listen to the

local representative.” The Company has representatives employed and trained to address the local methodology and culture for conducting business. Not listening to the local representative reduces the company’s image, prestige, and eventual profit. Since The Company competes internationally, services offered should be expanded internationally. The Company, a leader in the atmosphere ventilation market, would benefit by offering yearly maintenance plans for the SNOW.

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Appendix A – Representative Questionnaire

Dear Representatives:

The following survey should take about 10 to 15 minutes. The purpose of the survey is to help us understand what The Company does well and show areas for improvement in regards to \$250,000+ atmosphere projects using industrial automobiles such as the SNOW, WHITE, or FLAKE only. I appreciate the time you will take to fill out this survey. While you will reply to me via email, the survey results will be kept confidential. If you would like us to track your response then please provide your name on this sheet of paper.

1. With regards to \$250,000+ atmosphere projects using industrial automobiles such as the SNOW, WHITE, or FLAKE only, over the last two years how competitive has pricing from The Company been? If not very competitive, approximately what percentage are we too high?
2. With regards to \$250,000+ atmosphere projects using industrial automobiles such as the SNOW, WHITE, or FLAKE only, over the last ten years how competitive has pricing from The Company been? If not very competitive, approximately what percentage are we too high?
3. With regards to \$250,000+ atmosphere projects using industrial automobiles such as the SNOW, WHITE, or FLAKE only, what disadvantages does The Company have?
4. With regards to \$250,000+ atmosphere projects using industrial automobiles such as the SNOW, WHITE, or FLAKE only, what advantages does The Company have?
5. With regards to \$250,000+ atmosphere projects using industrial automobiles such as the SNOW, WHITE, or FLAKE only, what could The Company improve on with regards to handling atmosphere projects from design with Engineer's (such as Malcolm Pirnie) to bid stage to supply of product?
6. With regards to \$250,000+ atmosphere projects using industrial automobiles such as SNOW, WHITE, or FLAKE only, what does The Company do well with regards to handling atmosphere projects from design with Engineer's (such as Malcolm Pirnie) to bid stage to supply of product?
7. Please list any additional comments here.

Appendix B – Proposal and Associated Documents with Galvanized Steel

The following is the proposal with associated documents after running the model with the galvanized steel option. First, is the proposal form followed by the Scope of Work, followed by Attachment A, then followed by the form for Engineering, and lastly followed by the form for Order Entry.

Proposal Form

The Proposal Form, depicted below, is used as the cover page for the proposal and associated documents. It contains the customer details, proposal expiration date, coordinates the associated documentation, and provides the freight terms.

(Figure redacted)

Scope of Work

The Scope of Work, as shown below, is referenced on the proposal form, which provides details of the automobile construction and tire offering.

(Figure redacted)

Attachment A

Attachment A, referenced on the proposal form as shown below, provides a list of automobile sizes and quantities proposed, the quantity and model number of the tire per automobile, price per item, and the total proposal price. This is shown on the next page.

(Figure redacted)

Form for Engineering

The form for Engineering, depicted below, is not provided with the proposal. Once the company receives a purchase order, all of the previous documents along (inclusive of this document) are sent to Engineering to generate drawings and to review the design. The form for Engineering displays additional information that the Engineering Department will require.

(Figure redacted)

Form for Order Entry

The form for Order Entry, similar to the form for Engineering, is not provided with the proposal. This form is provided to Order Entry once the drawings have been completed. It is this form that is used to enter the order into the company's system. This is shown on the next page.

(Figure redacted)

Appendix C – Proposal and Associated Documents with 316 Stainless Steel

The following is the proposal with associated documents after running the model with the 316 stainless steel option. First, is the proposal form followed by the Scope of Work, followed by Attachment A, then followed by the form for Engineering, and lastly followed by the form for Order Entry.

Proposal Form

The Proposal Form, depicted below, is used as the cover page for the proposal and associated documents. It contains the customer details, proposal expiration date, coordinates the associated documentation, and provides the freight terms.

(Figure redacted)

Scope of Work

The Scope of Work, as shown below, is referenced on the proposal form, which provides details of the automobile construction and tire offering.

(Figure redacted)

Attachment A

Attachment A, referenced on the proposal form as shown below, provides a list of automobile sizes and quantities proposed, the quantity and model number of the tire per automobile, price per item, and the total proposal price. This is shown on the next page.

(Figure redacted)

Form for Engineering

The form for Engineering, depicted below, is not provided with the proposal. Once the company receives a purchase order, all of the previous documents along (inclusive of this document) are sent to Engineering to generate drawings and to review the design. The form for Engineering displays additional information that the Engineering Department will require.

(Figure redacted)

Form for Order Entry

The form for Order Entry, similar to the form for Engineering, is not provided with the proposal. This form is provided to Order Entry once the drawings have been completed. It is this form that is used to enter the order into the company's system. This is shown on the next page.

(Figure redacted)