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Resources to Improve the Efficiency and Effectiveness of ThaiWheel Wheelchairs

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Abstract

The goal of our project was to develop a resource package to help facilitate improvements in the ThaiWheel organization. The package included information for future opportunities and a program to calculate total wheelchair costs when making or buying parts. Methods included focus groups, obtaining government and manufacturing contacts, and writing an Economic Analysis and Total Cost program. Recommendations included future donation strategies, using the program to improve cost efficiency, and to make the large initial investment on the domestically supplied brakes determined in the scenario.

Executive Summary

The demand for wheelchairs far outweighs the supply, particularly in third world countries, like Thailand, where regulations and support for people with disabilities (PWDs) are limited. In response, programs are available world wide to help the disabled who need wheelchairs. In an attempt to help the disabled, ThaiWheel, a non-profit organization (NPO), was established in 1999. The factory was launched by a PWD, employs PWDs, and produces low cost wheelchairs. One such wheelchair is a three-wheel design inherent to Thailand and is geared towards functionality in a rural setting. Often the chairs are bought by foundations, like the International Support Group, which have collected money from donations and sponsors, in turn giving the wheelchairs to people who need them the most.

As a NPO, ThaiWheel's goal was to assemble wheelchairs at the lowest cost possible with optimal designs that meet production capabilities and client desires. The factory does not currently know the total cost of producing each wheelchair, but a few imported parts are very expensive and drastically increase the overall price. Also, ThaiWheel does not have sufficient time to research the needs of the market to insure the wheelchairs are meeting the needs of the disabled. If the cost of the wheelchair were known, if options were available to decrease the cost of these expensive parts, and if the consumers who receive the donated wheelchairs were more satisfied, the ThaiWheel organization could produce an appropriate and affordable wheelchair in an accountable and economical fashion.

In order to accomplish the goal of developing a resource packet, several steps were undertaken as methods. The first step required the team to determine the needs of two organizations, ThaiWheel and the International Support Group, and create a project goal that encompassed both groups' desires. The second step involved conducting and analyzing three

focus groups to determine customer needs for the tricycle wheelchair produced by the ThaiWheel factory. The three groups consisted of older Thais, manufacturers of wheelchairs, and young wheelchair users. To complete the third step of obtaining resources to give the ThaiWheel organization, contacts were made at multiple government ministries and with different part manufacturers in Thailand. The final step included the creation, testing, and analysis of a program that the ThaiWheel factory could use to calculate the cost of each wheelchair and evaluate options for making parts or buying them from various locations.

After conducting the methodology, many findings were obtained that would lead to recommendations to improve the efficiency and the effectiveness of ThaiWheel wheelchairs. The findings fell into two major categories of needs assessments and the resource package. The finding for the needs assessments came from the focus groups and through informal interviews with the factory managers. The other results came from the development and analysis of the program and information obtained to place into the resource package.

The findings from the needs assessments related to both the needs of the users of the wheelchairs and the ThaiWheel organization. The users of the tricycle wheelchair and the manufacturers described general use of the tricycle wheelchair to be for outdoor distance travel but not for children. We also learned that general problems with the tricycle wheelchair include difficulty with entry and exit due to wheelchair rolling, difficulty starting the pumping action for propulsion, and difficulty finding spare parts for repair and replacement. Other findings were that disabled children spend most of their time inside and if given the choice would choose a standard child wheelchair over a tricycle wheelchair. Relating to the ThaiWheel organization, we found through informal interviews that total cost for each wheelchair is currently unknown and that certain parts can be found in Thailand of the same quality, but require large lot sizes and therefore high initial investments.

Findings relating to the resource package included business contacts, a functioning program to conduct Make or Buy Analyses (MBA) as well as calculate total cost, and examples for use of the program and package as a whole. Also included are the recommendations made to improve the cost efficiency of the ThaiWheel factory. Multiple leads were followed to investigate the opportunities available for the ThaiWheel factory resulting in a list of government ministries and possible part manufacturers. The program developed was analyzed for functionality and ease of use. After the primary user tested the program, both he and the group were satisfied with the results. Further analysis of the program was conducted with a specific example using brakes currently bought by the ThaiWheel organization showing substantial monetary savings. The resource package also includes the discussion of many possible future options including a group buying plan and manufacturing parts currently bought at very high costs.

Conclusions drawn from the results and analyses led to the development of six recommendations to the ThaiWheel factory. The recommendations attempt to improve the efficiency of the ThaiWheel organization by giving them a better understanding of opportunities available for wheelchair cost reduction and a more accurate picture of the cost for each chair. Recommendations for improvements in the wheelchair design allow for enhancement in the effectiveness of the wheelchairs for the consumer.

The first two conclusions were drawn from all three focus groups, regarding the use of the tricycle wheelchair by the old and young Thais with disabilities. Neither the old nor the young spend a significant amount of time in transit, and spend most of their time indoors. Tricycle wheelchairs were not designed for use indoors or by the young or the elderly. Also, design alterations to make the three-wheeled chair suitable are not feasible. Therefore, we recommend that for future buying strategies, standard adult or child wheelchairs should be purchased to donate to elderly and young people with disabilities, respectively.

The next conclusion was developed from the tricycle wheelchair users. The most common problems with the design included difficulty upon entry and exit, difficulty finding spare parts for repair and replacement, and difficulty starting the pumping action for propulsion of the tricycle wheelchair. Suggestions for future designs included adding reflectors to help with safety at night and adding a parking brake. Therefore, to improve the quality of the tricycle wheelchair produced by ThaiWheel, we recommend that parking brakes and reflectors be added, and to make some spare parts available for retail sale to replace broken ones.

The next recommendation is that the ThaiWheel factory enters the information for all their wheelchair parts into the Economic Analysis and Total Cost Program, regularly update the information, and calculate the total cost of each wheelchair. In this manner, the future comparisons of parts and their effect on the overall cost can readily be determined. The information, however, is subject to change, and it is therefore extremely important for accuracy to update each piece of information on a recurring basis.

The final two conclusions and recommendations are based on use and results of the Economic Analysis and Total Cost Program. From the example input into the program, we recommend that ThaiWheel find the funds to make the initial investment to purchase the domestically supplied brakes to save up to 37% per year on brakes alone. The other recommendation relating to the program is that ThaiWheel use the Economic Analysis and Total Cost Program to demonstrate to other wheelchair manufacturers the opportunities and savings that are possible from a group buying scenario. These two recommendations are both good examples of how to use the resource package, but not the only options feasible or available.

In the goal of the project, the desire was stated to create resources to improve the efficiency and the effectiveness of the ThaiWheel wheelchairs. Through the information in the resource packet, both areas were evaluated. Efficiency relies heavily on cost, and through with

future use of the Economic Analysis and Total Cost Program, the cost of the currently produced wheelchairs can be reduced. Effectiveness relates to the functionality of the final product for the user. The result of speaking with current users and manufacturers of wheelchairs led to recommendations for future designs changes and donation strategies to give disabled users a better product. Overall, through cost reduction and improved functionality, it is our hope that the lives of many disabled individuals will be improved.

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1.0 Introduction

Over 10% of the world's population is comprised of people with disabilities (PWD's)[i]. Five hundred million with disabilities are in developing countries worldwide and over 20 million of them need wheeled devices for movement[ii]. The demand for wheelchairs far outweighs the supply, particularly in third world countries where regulations and support for people with disabilities are limited. As the numbers of disabled multiply, the need for affordable and functional wheelchairs grows ever-increasingly evident. Through previous demand, attrition, and new injuries there is a constant demand for affordable and functional wheelchairs. Without an appropriate and functional wheelchair, living an independent and productive life is virtually impossible[iii].

Programs are available world wide to help the disabled who need wheelchairs. Thailand was formerly considered a third world country and until very recently qualified for many worldwide aid programs, such as the Red Cross, but many areas outside Bangkok can undoubtedly still qualify for those programs[iv]. In an attempt to help the disabled, especially in these rural areas, ThaiWheel, a non-profit organization (NPO), was established in 1999. The factory was launched by a person with disabilities (PWD), employs PWD's, and produces low cost wheelchairs. One such wheelchair is a three-wheel design inherent to Thailand, which is geared towards functionality in a rural setting. Often the chairs are bought by foundations, which have collected money from donations and sponsors, in turn giving the wheelchairs to people who need them the most.

As a NPO, ThaiWheel's goal is to assemble wheelchairs at the lowest cost possible with optimal designs that meet production capabilities and client needs. The cost of a few parts, however, drastically increases the overall price of each wheelchair because the parts must be imported from Japan and Korea, eliciting high shipping costs and import tariffs. How much

these parts increase the total cost of the wheelchair is yet unknown, because ThaiWheel cannot currently calculate this statistic. When developing a business plan to start a factory for the production of wheelchairs, the Center for International Rehabilitation insists the first step should be to calculate the costs to manufacture one wheelchair[v], which is not being done. And as far as client needs being met, the concern has been raised as to the practicality of the three-wheeled design for the much weaker, old and young populations of rural Thailand.

Other organizations have initiated programs to provide chairs for the disabled of rural areas in third world nations. The Center for International Rehabilitation in Chicago Illinois trains persons with and without disabilities to start their own businesses making wheelchairs for the disabled in foreign countries[vi]. Ralf Hotchkiss, director of Whirlwind Wheelchair International at San Francisco State University, consults third world country wheelchair manufactures and holds workshops to better assist the production[vii]. A British charity makes a wheelchair called the Mekong for under $80 U.S. and distributes them to different areas of Cambodia[viii].

All these projects produce inexpensive, mass produced wheelchairs for people of third world counties, and all of them know exactly how much each chair costs to manufacture. None of them, however, produce both tricycle and standard wheelchairs that follow the appropriate technology standards of making products that best suit the environment being placed into. By knowing the total cost of each wheelchair, by capitalizing on opportunities to reduce the cost of expensive imported parts, and by insuring that the tricycle design is functional and useful to the rural Thai disabled, the ThaiWheel factory can produce an inexpensive wheelchairs that go a step beyond the products produced by the charitable organizations found in other nations.

The goal of our project, therefore, is to develop a resource packet for future improvement in the efficiency and the effectiveness of the ThaiWheel organization, which will contain consumer input for overall product satisfaction, a list of importing, exporting, and

manufacturing opportunities, and a program to calculate total wheelchair cost in terms of making versus buying parts. The use of the resource packet can aid the factory in achieving its own goals for helping the disabled in Thailand by reducing the costs of each wheelchair, employing more PWD's with future manufacturing expansions, and through the insurance that the product made suits their needs.

2.0 Literature Review

In order to accomplish our goal, to develop a resource packet for future improvement in the efficiency and the effectiveness of the ThaiWheel organization, we must have a good understand of all pertinent information. To understand the need for this product in society, we must look at both the wheelchair and Thai culture, with respect to idea that links the two, appropriate technology. Therefore, we begin with an introduction to Thailand's society and norms, revealing pertinent information regarding the atmosphere into which the wheelchairs are placed, and the need for their constant production. Since Appropriate Technology deals with the placement of technology into society, especially underdeveloped ones, the idea is articulated next and forms a framework for the project as a whole. The three remaining sections deal with the aspects of society and technology in terms of two data gathering and evaluation techniques and the current known information regarding specific wheelchair technology. The first process is one of social attitude data collection followed by a discussion of current wheelchair technology. Finally, an evaluation technique for making or buying a part is discussed as a reference for what the program written to be included in the resource packet will be calculating.

2.1 Social Factors Affecting the Disabled in Thailand

The disabled of Thailand face a unique society with cultural norms and attitudes that directly affect how they live, how they work, and how they are perceived as a group. Religion, the economic status of many people with disabilities, and the government largely affect these social attitudes. Unemployment, difficulties in purchasing wheelchairs, and Buddhist religious views are key concerns of people with disabilities who need wheeled mobility devices, but hope

is not lost. Government and non-government organizations (NGO), as well as religious groups, have programs to help the disabled, especially those who need wheelchairs.

In Thailand 95% of the people are spiritually united through Buddhism, which tends to shape the lives and social norms of many Thai, including the disabled. The Thai disabled may see their situation as a result of how they lived in a prior life[ix]. This belief may affect their self-image as well as how they are perceived in society. Even the relatives of the disabled are not free from some forms of unjust discrimination. Marriage opportunities for the relatives of a person with a disability may be adversely affected because of the belief that a disabled person is a curse on a family.[x] The Buddhist religion does, however, call on its followers to give to the needy, sick and disabled in order to make merit. It is the disabled beggars duty to beg and the duty of the wealthy to give and help.[xi] One of the largest influences on Thai Society is the predominant religion, Buddhism.

Other aspects of Thai society play into the view of the disabled as well. For example, many feel that Thai people may not generally like to accept aid. The values of self-reliance and self-help are deeply rooted in Thai tradition. Too much charity and help may weaken their self-reliance and undermine the values so key to Thai society. Recent examples, however, have shown this not to be true for the disabled. The Christian Foundation for the Blind has been helping rural Thai citizens receive the benefits that they need sense 1978[xii]. They claim that rural Thais are more than willing to accept help for their disabilities; it is an opportunity to become productive citizens again or for the first time. The problem lies in that information about NGOs, Community Based Rehabilitation (CBR), and other programs to aid the disabled are difficult to obtain, especially for the disabled themselves.[xiii]

Many signs show the status of the disabled is changing in Thailand as well; there is a growing optimism brewing throughout the country. In the Sydney Olympics, for instance, the people of Thailand were proud of the success their national wheelchair participants achieved.

Thailand's Paralympic teams reached a milestone in the history of sports for the disabled by clinching eleven medals in Sydney[xiv]. During a difficult time in the country's drive towards democracy, a reason for rejoice resides in the success of its Olympians. In another example, Narong Patibatsaranakij, the only disabled member of the Senate describes his optimism by commenting, "Just being able to be a candidate in the election is a sign of success. At least, we're not discriminated against in our candidacy, which proves we have full participation as intended by the constitution[xv]."

Despite these changes, many hurdles still remain for people with disabilities, especially in a struggling economy. Due to the recent economic crash in Southeast Asia, that hit Thailand particularly hard, employment is difficult to find for even the most qualified applicants[xvi]. If special considerations are necessary to hire wheelchair users, particularly in terms of building access, it may be easy to overlook them in a flooded job market. Bangkok as a whole is a city with little or no public access for the disabled, with high curbs and very limited ramps to allow for entrance and exit. It is possible that employers may feel less inclined to employ a disabled person in a wheelchair because of these requirements, particularly when a person who does not need the special adjustments is just as eager for job placement.

How then, do people with disabilities make a living? Many disabled wheelchair users, have found work selling lottery tickets for the government. This group, in essence, has formed its own community around each other, finding a niche built on work partners and relations[xvii]. Many though, are not so lucky and are reduced to begging on the streets with jangling mugs, often in highly trafficked areas. For those in rural areas, working is likely even more difficult when long distances and rough terrain often separate villages and towns. The current economic situation of the disabled is poor and many are left unemployed, or in need of a wheelchair for simple mobility.

The need for wheelchairs is not only large, but is vastly comprised of those who cannot afford them. Of the 1.8 million people with disabilities in Thailand[xviii], over 20,000 of them need wheelchairs every year[xix]. With only 5,000 wheelchairs produced by all the factories in Thailand, and with the percentage of disabled growing steadily every year, the demand is currently, very high. The target market, however, is comprised largely of poor and needy individuals and the ability of the wheelchair consumers to buy the product for themselves is limited. Only 5% of people who need wheelchairs can afford to buy them on their own[xx].

Aware of existing challenges regarding the disabled, the Thai government has made attempts at improving the situation. For example, land was given in northern part of Bangkok to organizations whose goal was to help the disable, like the Foundation for the Blind and the Department for Public Welfare for the Crippled[xxi]. Currently the government also buys 2800 wheelchairs annually from Thai manufacturers to give to the disabled in need[xxii]. Still, this only represent a small portion of the needs the disabled have and by 1997, the governmental support of the disabled in the work place was only around 1% of the total needed. The rest is supplied through private funding.[xxiii]

With so many people in need, there are numerous organizations, both NPO and private sponsored that aid the disabled. Often, support comes from groups who buy wheelchairs to donate to those who cannot afford them. The International Support Group (ISG) and Wheelchairs & Friendship Center of Asia (Thailand) (WAFCAT) are two groups in Thailand who do just that[xxiv]. Both organizations are supplied wheelchairs through a NPO, called ThaiWheel, which manufactures an inexpensive and good quality product.

Started in 1992 as a workshop and maintenance clinic, the ThaiWheel factory was known as the Association of the Physically Handicapped of Thailand (APHT). The objective was to teach the Thai disabled how to help themselves through training in the knowledge of fixing wheelchairs, particularly their own. The Social Welfare Organization covered the start-

up costs and donated one hundred wheelchairs to the APHT. ThaiWheel was founded in 1999, and expanded the capabilities of the maintenance facility to include the production of wheelchairs, largely through funds received from WAFCAT. The Thai with Disability Foundation is presently overseeing the finance and management of the factory and the objectives have grown to encompass the maintenance, production, research, and development of wheelchairs as well as the employment and training of disabled persons. The underlying purpose of ThaiWheel and its predecessors has always been to improve the quality of life of the Thai disabled[xxv].

2.2 Principles of Appropriate Technology

Thailand maintains a unique collection of needs and cultures so Appropriate Technology (AT), which is a philosophy that attempts to improve the quality of new products and programs by recommending design choices best meeting the specific social, economic, and intellectual requirements of the user, has to be utilized. People facing a particular problem are not all identical, making the exact optimal solution location specific and preventing an acceptable global solution from being formed. While being a simplification, AT can be described as a collection of guidelines to assist developers in generating a plan that meets this specialized collection of requirements. Four different categories divide AT's set of instructions into logical groupings. Sustainability, the ability for a program to have beneficial long-term results, is one of AT's most important sections. Another critical segment is selecting the correct level of technology because the most advanced is not always the best and can even be detrimental. Despite its name, AT brings into consideration all facets of project planning from technology selection to incorporating the program's beneficiaries. Maximizing the use of locally available materials, to reduce cost and improve reliability, is also stressed by AT. Incorporating the users

into all aspects of the program constitutes the remainder of AT's numerous and diverse guidelines.

The first major category of AT, states that for an aid program to genuinely assist a group of people, discernable and sustainable benefits must be produced[xxvi]. Many design choices provide only a temporary improvement, but following the principles of AT, programs can easily be geared for a long-term solution that will maximize the benefits from the project. Not only must a project be able to maintain any improvements generated, continuing progress must be maintained, especially after the project team has terminated their stay. If a simple but effective improvement is made to the construction of ox carts, the local people can use their inventive spirit to build on the new advancement, while providing a complex improvement will prevent any future modifications[xxvii].

To further ensure long-term benefits, the process utilized by the aid program must be the dominant goal, overshadowing any immediate results. Advancement of these types of projects does not occur in substantial increments but rather in small additive steps. While the use of inappropriate foreign technology may provide a leap forward, sustainable progress will eventually surpass any short-term advancement[xxviii].

A dominant area of AT teaches that even though technological innovations may solve a great deal of tribulations in advanced countries, they may be inappropriate for less developed nations. While not always obvious, there are many reasons why applications of technology must be preformed with great care. The latest and most sophisticated of technologies were designed for advanced programs in highly developed locations and such are not always appropriate. These types of improvements generally involve large start-up costs and require numerous complex replacement parts, all of which are not possible or available in third-world countries.

Also, supplying an under-developed country with the latest and most expensive innovations may sound like a valid solution, but that action may retard the current level of progress or actually increase difficulties experienced by the people. Ken Darrow and Mike Saxenian, authors of the Appropriate Technology Sourcebook, describe how farmers in a long term study project were coerced into using ideas of fertilization that were commonplace to other areas as suggested by the study's recommendation. In actuality, the conventional wisdom was inappropriate for these particular farmers causing instead adverse effects and unprofitable results. The farmers' crops did not grow as well as previous years would indicate they should have and fertilizer costs further reduced their income for that period of time[xxix].

Another similar principle explains that while highly technical methods can produce numerous goods quickly and inexpensively, programs designed to aid the needy should not demand large initial investments[xxx]. Many non-profit organizations do not have large endowments so substantial expenditures of capital are not viable options. Even if the association received some financial backing, the cost would eventually be deferred to the locals, who may not be able to absorb the increased cost.

The wide breadth of technological guidelines stresses that since the availability of spare parts for advanced tools is normally limited, many forms of technology would not be appropriate for the region. Components used in a device or tool are often as complex as the tool itself and are in such low demand that regional production is not feasible, therefore they would not be available. If cars were given to the people, repairs would have to be made after a little use but since the parts are not available, and many cannot easily be made outside a factory, the vehicles would have to be abandoned.

A major portion of AT stresses the possibility of reducing the cost of manufacture and the ability to tame inventory dilemmas by increasing the usage of locally available materials.[xxxi] Availability, quality, and ease of acquisition, as dictated by the location of the program or

factory, will help dictate the materials used in the design. Any plan dependant on imported goods is bound by many economic factors. First, the cost of the product will be related to the cost of the supplies on the global market. If one of the materials used in the construction of the device increases in value, the final cost of the apparatus will be forced to escalate. Availability can also be an issue. The supply of different materials in the global market can change dramatically in a short period of time, possibly hindering the factory's ability to maintain production. Transportation of goods is expensive; imported goods carry high tariffs and middlemen increase cost, so the use of local resources can help to lower the final cost of the apparatus.

Encompassing the remaining guidelines, AT's last section teaches that citizens of third world countries generally do not have advanced training and cannot maintain sophisticated equipment that has been brought into their community. Project teams are usually not permanent fixtures with their departure from the location being inevitable. After their parting, only the locals will be left with the improvements. If the technology used was of a remotely high level and the local people did not learn to adequately use it, then the program's results will implode. Design improvements can only come after understanding and familiarity with the current design. Without this comprehension any possible progress will stagnate or even recess requiring another project team to work on the same problem instead of having the original team's goal of simply giving the locals a guiding step to becoming advanced by themselves bloom[xxxii].

Another aspect of AT that considers the local people to be valuable helps to ensure substantial long-term results by stressing that local people should take an active role in the design process so as to develop a sense of ownership. Incorporating them into the design stages will help cultivate a desire and ability from the natives to continue improving their situation long after the project team has left[xxxiii]. Two-way communication between the local community

and the development group will encourage the locals' growing skill base and help in preventing misinformed decisions[xxxiv]. Another advantage of allowing the local population to participate in identifying and addressing the needs is that the overall endeavor will likely have a greater harmony with local traditions and values[xxxv]. While underdeveloped, the natives still have many skills and resources that can be tapped for a more worthwhile project, many assisting in logistical problems such as finding ways to efficiently use land and resources which do not contain all the desired properties. Even design skills such as imagination, initiative, and assistance in setting up a local institution can be sourced from the inhabitants of the project site[xxxvi]

2.3 Research Methods for Needs Assessments

The sociology of the populace delegates what technology can and should be used, yet assessing those needs is a complicated task that involves an in depth data gathering and analysis procedure. Indeed as appropriate technology suggests, the specific needs of the target people should be incorporated into any design alterations. Acquiring this information will allow the creators of the project or design to maximize user satisfaction. One means for collecting a listing of the regional requirements is through different forms of interviews, a form of qualitative analysis.

2.3.1 Interview Types

While there are many forms of interviews, two styles, single participant (SPI) and focus group (FGI), comprise the most commonly selected. Despite SPI and FGI having similar results and tools, their specific methods and objectives differ. The most obvious difference between SPIs and FGIs is the number of participants involved with each activity. As the name implies, SPIs only have one participant, creating a two-person discussion. FGIs on the other hand are a group interviewing methodology consisting of the interviewer and between three to

twelve participants[xxxvii]. To correctly choose which interviewing method is the most appropriate, the objectives and time requirements of each much be compared.

When the scope of the data desired is broad, FGIs would be more advantageous while SPIs would provide a narrower but deeper channel of information. Due to the discussion form, FGIs are not able to seek out in-depth and specific information from the participants like a SPI would, but FGIs let the moderator observe interactions between the participants[xxxviii] sometimes creating communication that would normally not occur[xxxix]. Focus groups are often used to find background information for future research, to generate hypotheses for later investigations, and to help the researcher understand the market problems or specific needs of a group of people. Designed properly, focus groups can be used to examine or discover information about areas where little previous knowledge is currently available. While the researcher sacrifices some ownership of the interview, the participants help mold the flow of the meeting, greatly reducing the need for prior knowledge to generate probing questions. Since each respondent bases his or hers next comment on the previous observation, a greater sense of context and depth can be generated. The comparisons that are performed by the participants help to make each answer individualistic and add a fuller meaning to the data.

Time available for conducting the interviews can play a pivotal role in deciding which manner of information collecting is the most appropriate. The time restriction could come from either party, the organization that needs the analyses by a certain date or by the participants who may only have limited availability. Conducting SPIs with a large number of participants would be highly time consuming but several focus groups would be able to interview all of the participants in a greatly reduced time period[xl]. The drawback to using FGIs to reduce the required time is the reduction in quality and quantity of the data. Through practice and experience, Fern, author of Focus Groups: A Review of Some Contradictory Evidence,

Implications, and Suggestions for Future Research, discovered that FGIs will only produce approximately seventy percent of the ideas the equivalent SPIs would have generated[xli].

2.3.2 *Interview Design Techniques for Improving Effectiveness*

Despite the differences in ideology of the different forms of interviewing, many factors and considerations are in unison. These similarities can be grouped into three different chronological categories, pre-interview, during the interview, and post interview. While each time segment is equally important, the number of details in each varies. The quantity of variables and decisions taper when designing the interview for only a few participants. After all of the choices dealing with the comparable aspects of interviews are analyzed, consideration has to be given to the portions of interview style that do not always have an analogous counterpart to another style, such as the deriving the ideal number of participants for a FGI and dealing with one participant's comments influencing others.

One of the first considerations that must be made when designing an interview is the formality level of the setting and structure. Formal interviews are conducted in a business-like atmosphere; process is carefully monitored and formal dress and titles are used when addressing the interviewee. Informal interviews consist of a more relaxed atmosphere, including using first names and producing a more conversational style of discussion, many times without prepared questions. In any type of interview, whether it is formal or informal, one should keep in mind not to confuse informality with not being professional. Interviewers and interviewees can be comfortable in either setting[xlii].

When constructing an interview, care must be taken to not introduce biases into the results. These damaging effects can be the consequence of several different mistakes in the planning phase. Selection processes for the participants can introduce bias because limiting the candidates can produce groups consisting of only one section of the target audience or depriving

a segment from participating[xliii]. The questions asked in an interview can also generate bias by leading the participants down a certain avenue instead of letting the participant decide the course of conversation. Running the interview without specific questions, only general guidelines, may help to eliminate the possibilities of bias[xliv]. Perceived safety can also greatly affect the amount of bias in the results. Participants will only join in the discussion and speak truthfully if they believe that there is little harm[xlv]. If an employer or a person deserving of respect from the participant, answers and responses may be tailored as to not offend or harm these observers for fear of repercussions.

Similar to the required decision about the interview's formality level, the degree of standardization, which implies the consistency of the questions, must be set prior to starting the interview. There are three intensities that could be used, standardized, semi-standardized, and unstandardized[xlvi]. The decisions hinges on whether or not to ask all informants a standard list of questions, a core set with a few spontaneous probes, or to create a different set of questions for each participant[xlvii]. Several factors exist which can influence the decision. Participants' backgrounds create specific requirements for the interview questions, because there will be different intellectual levels, jargon, and cultural influences. Some questions that are well suited for a given group may be offensive or misunderstood by another[xlviii]. Since each interview is unique, unexpected misunderstandings and possible avenues of questioning may appear. When this occurs, the interviewer may consider using probes, which are specific and guided questions designed to either remove any misunderstandings or to delve further into a particular topic[xlix]. If the moderator does not have enough prior knowledge about the material or the subjects, an unstandardized format may be considered so the correct questions can be formulated and asked in a spontaneous manner[l].

A moderator's technique and skill greatly effects the questions used and the quality of the generated responses[li]. Appropriate wording and vocabulary, open-ended versus short

answer questions, and verbal and non-verbal cues are all critical components to a high quality interview and need to be incorporated. Key skills that the interviewer needs for accurate data collection are proper wording of the question, listening, remembering, observing, judging the participant responses, and behavior and validity of the statements made by the respondent. When conducting an interview it is imperative to ask questions in a manner that will stir interest because this line of questioning tends to create an atmosphere for discussion and energetic responses[lii]. Language used during the interviews must be suitable for the participants, preventing any possible misunderstanding or unintentionally insulting anyone present

Tactics play a pivotal role in the successes of an interview. Many choices exist, such as how to pre-test the question, dealing with the decisions about the logical ordering of topics, sub-topics, questions, probes and choosing a style that the moderator can adequately maintain and draw out the desired responses. After all the research has been delegated one should pre-test the questions that will be used during the focus group interview[liii]. Pre-testing questions is done by actually conducting a focus group session. Usually it is first tested on other research members or people who are familiar with the topic. The selection of the first couple of questions can set the mood for the rest of the interview. Querying about a fun topic such as what hobbies the participants have may accelerate the level of participation while asking a question whose answer is similar for all participants can decrease the felling of being different[liv]. Using broad open-ended questions first and more specific goal oriented questions last is the most common order used to ensure a good breadth of responses[lv].

After the design process has finished and the interview session begins, great consideration must be given to non-verbal cues and communication, which may be misinterpreted by either party. Some of these cues would include eye contact, voice, and body language. Examples of non-verbal communication can be silence, pacing of speech, tone of voice, gestures and information flow which all signal the interviewer of underlying ideas and

information not actually spoken. Non-verbal communication and cues also have the function of having the respondent reply honestly and in a more complete way than that of the verbal manner. Controlling the pitch, pace, and the intonation that the researcher uses throughout the interview can also help to regulate the overall atmosphere. Two ways to show interest in what the interviewee has to say are eye contact and leaning forward. By doing so the interviewer shows involvement and the desire to make the conversation more intimate. Leaning back can, however, decrease the pace to slow the conversation down and lighten the mood of the questioning. These methods, as proven by a study done by Robert Rosenthal, are acquired with experience and can be learned with time. This type of communication plays an important role while conducting an interview because it creates a link between the interviewer and the interviewee so that a specific message can be communicated as well as the understanding of the message[lvi].

A key item to pay attention to while performing an interview, as important as verbal and non-verbal forms of communication, is the documenting of the interview, typically preformed with note taking and a tape recorder. The ideal method to document an interview is the one that will record the most precise and complete information possible. Notes provide clues on what needs to be probed more, and also includes vocabulary and common terms that were used during the interview that one should use for the probing. If a tape recorder is used, after the interview is finished the interviewer should transcribe whatever information was recorded from the meeting. Transcribing is the method of taking the information that has been recorded and putting it into writing. The notes and recordings also provide information for the analysis after the interview has been conducted[lvii].

After preparing and conducting the interview and the transcribing is finished, one can do a follow up interview, also known as a post interview. These interviews are useful when there is still information that might be needed, confusion with some of the information that was

given or to note any significant changes in the respondent[lviii]. This type of interview is not only used as a follow up but may also serve as an ego builder. This is usually done in order to make the respondent feel comfortable and have a good frame of mind, so that no negative attitudes to potential respondents will be spread[lix] and will hopefully secure the interviewer another interview with the same person or different respondents.

While many techniques are similar for almost every interview, some do not apply to all interview types, one being the number of people to participate in a group interview. Unlike fixed number interviews, such as SPI, group interview designs need to take into consideration several factors when deciding on a size for the group. One of the most limiting aspects to the group size is participant availability. If only a certain number of people can be found, then the focus group can only include that number of partakers. Another critical factor is time. With more people in a focus group, each participant will have a proportionately smaller time to speak. Too small a group could similarly be detrimental from the limited number of sources from which ideas can flow.

Another consideration that must be made when an interview consists of multiple participants is response bias. This form of bias consists of answering a question in a manner that may taint the truth or by shifting ones opinions[lx]. It often makes the research of a given subject difficult because answers may often change from person to person after hearing someone else's views about the subject being discussed. Even though changing ones opinions is a sign of performing in a normal manner, taking notice of this act in a focus group session or an individual interview is often very difficult for the interviewer. Opinion changes often take place because another member convincing others of their reason often presents new evidence. With time the moderator is able to notice opinion changes and why they have taken place..

2.4 Wheelchair Design Considerations

After discovering the needs of the people, meeting those needs with the appropriate technology requires an understanding of the currently available technology and resources. Achieving the desires of the disabled necessitates study of the modern wheelchair as a complex piece of machinery that is able to assume many different forms. Wheelchair designs range from sports wheelchairs to tricycle wheelchairs, but all have common characteristics. Most chairs include similar components and cause similar injuries during repetitive use from daily activities. The overall performance of a wheelchair, however, relies heavily on the construction and the materials used. Understanding their benefits and shortcomings of wheelchairs is crucial to the successful implementation of a new design[lxi].

2.4.1 Wheelchair Designs

Although the performance and level of complexity varies significantly from country to country and from wheelchair to wheelchair, many similarities can be established. Most chairs fall into a category in terms of general type and many components of wheelchair, such as a caster or hub, are common to multiple varieties. The overall performance of the wheelchair is often correlated to the material and design selection, and its ability to reduce repetitive stress injuries.

Wheelchairs tend to fall into one of four categories: adult standard, sports, child standard, and tricycle wheelchairs. The standard wheelchair includes armrests, stroller handles, and brakes and is characterized by the cross-brace frame and swing-away foot rests. Sports wheelchairs are considered to be the most popular variety for handicapped individuals that have use of their upper bodies. They are lightweight, are much easier to maneuver in sports, and require minimum effort. Young adults and children need wheelchairs that will accommodate their growing needs. Youth chairs include a more "social" and aesthetically pleasing appearance to the eye. They are designed to fit in a classroom setting and social environment.[lxii] The

tricycle wheelchair is three wheeled model that is typically used in more rural areas where the road and ground conditions are much more uneven. The more sturdy design allows for easier distance travel, despite its larger size and weight. With a driving lever that pumps back and forth, the chair can be propelled forward at a decent speed.[lxiii]

Each one of the four categories of wheelchairs, however, can be customized because the standard wheelchairs do not always meet the specific needs of certain handicaps. Since specialized wheelchairs are varied in their design and target user group, this addition covers a wide breadth of disabled peoples. Some of these focused chairs consist of outdoor-based designs, proportions to accommodate large girths and heights, and tricycle based chairs. Despite the availability of specialized wheelchairs, many hospitals and institutions still use an economical, standard wheelchair, commonly referred to as a depot chair.[lxiv]

When wheelchair designs are considered, two factors that play key roles in the overall design are the performance of the chair and the ability of the chair to reduce repetitive use injuries and sores. Many areas need to be considered in the performance of the chair including its degradation over time, its strength and stability from material selection, and the ease of use for the disabled person. The most technically advanced wheelchairs tend to allow for easy entry and exit of the wheelchair, and allow beneficial maneuverability in tight conditions.

Stability of the chair is most commonly associated with the materials used in the design and the position of the rear axle. The frame of wheelchairs tends to be made of either steel or aluminum. While steel chairs are much more heavy and difficult to maneuver, they are still common, especially in underdeveloped areas because aluminum is much more expensive. Frames can be found in rare instance of other materials, but are neither recommended nor commonly sold because both steel and aluminum have been proven both sturdy and durable for everyday use. The other stability factor is attributed to the rear axle being just behind the center of gravity. In this position, the steadiness of the wheelchair is maximized[lxv]. Even when factors

such as ease of tipping are considered, from both the front and side planes of the chair, this position has proven to be solid.

The second key factor in performance is the ability of the wheelchair to reduce stress related injuries. Because the human body never had a consistent need to perform the repetitive task of pushing the wheelchair, the muscles and tendons in the body did not evolve to a state where this action could occur effectively.[lxvi] The repetitive motion can add unneeded stress to the remaining functional appendages. Shoulder injuries to tendons and carpal tunnel syndrome are the most common health problems and can be lessened or prevented with better wheelchair designs. Placement of the rear axle of the chair plays a dominant role in the forces required to propel the device. If the axel were to be moved in front of the shoulders, the peak push-rim forces would be decreased, reducing the number of thrusts required by the user. If the shoulders were lowered in relation to the rear axel, the angles would complement the human physique better, increasing the movement's efficiency.[lxvii]

Poor posture of the person in the chair can also cause long-term difficulties with back and neck pain. The poor posture is often the result of a combination of factors not limited to poor seat back angle or stiffness, uncushioned seats, or soft backed chairs[lxviii]. Armrests at uncomfortable heights can cause the person in the chair to rest in slouching positions and lead to spinal discomfort through time as well.

Other common conditions that can ensue through heavy usage are bedsores from extended stays in the position in the wheelchair, and soreness in all joints heavily used when propelling the chair forward[lxix]. Although most of the conditions resulting from extended wheelchair use cannot be wholly prevented, they can be improved by new designs, which better suit the ergonomics of the user.

2.4.2 Components

To adequately understand the design limitations of the wheelchair, the components that make up the mobility aid have to be known. Cost factors can affect what types of components are practical for a wheelchair design within a specific budget. Items that result in greater performance generally are higher in value so the advantages of each type must be weighed against the cost. Care has to be taken to design a wheelchair that will truly help the handicapped and not be a simple merger of separate good ideas. While having a wheelchair is better than not, if the chair's conglomeration of components inadequately answers the needs of the user, only negligible benefit will be gained.[lxx] There is a difficult cost-benefit analysis that has to be performed when deciding which components to include and what quality to use because cheapest configuration is not always best. Therefore, two main parts to the wheelchair, the wheel sub-assembly and the seat sub-assembly are discussed in terms of their costs and benefits. The wheel sub-assembly consists of the wheel, tire, caster, push rim, locks, and brakes, while the seat sub-assembly is comprised of the seat, armrest, and footrest.

The wheel sub-assembly consists of all of the different components of the wheelchair that allow movement to commence. These components consist of the wheel, tire, caster, push rim, and locks or brakes. While the wheel is the only critical part of the sub-assembly, the other components are needed to create an effective and efficient chair.

Wheelchair wheels exist in numerous forms and varieties but are fairly standardized in advanced nations. The large wheels usually placed in the rear of the wheelchair are either spoked or mag. Spoked wheels consist of many, usually thirty-eight, thin metal bars that hold the rim of the wheel on to the hub. Mag wheels have five or six plastic ribs that connect the hub to the rim of the wheel. Although lighter than mag wheels, spoked wheels are more likely to fail. The spokes are not as durable as the ribs of a mag wheel and may bend or brake. Most large wheels have a diameter of 24 inches. The larger the size of the wheel the better the user

can grasp to the rims and propel the wheelchair. Rough terrain is also easier to traverse with a larger wheel[lxxi].

Three deviations from the standard wheelchair wheel that are generally found in developing countries are bicycle tires, rims with wooden spokes, or solid wooden wheels. Since these other types of wheels are normally constructed with inexpensive materials that provide adequate performance, they can be considerably more economical than standard wheels. Non-standard wheels are not altogether very common though because they have some distinct disadvantages. Wooden wheels are generally heavier than others and in wet conditions, the wood may not hold up as well as metal or rubber. The spokes of a bicycle wheel are generally weaker than the spokes in a standard wheelchair wheel and may break unless strong spokes are used[lxxii].

While some designs simply use wheels, most wheelchairs incorporate some form of tire on the wheels. There are many different materials that can be used for tires. The standard wheelchair tire consists of solid rubber or a pneumatic (inflated) rubber shell. Despite the bumpy ride when rolling on rough ground with solid rubber tires, they allow decent speeds to be achieved on smooth surfaces. Due to the irregular ride, solid tires are only recommended for indoor use. Pneumatic tires are ideal for outdoor use because of the shock absorption offered by the inflated wheel. These tires can puncture, so a repair kit must be available to guarantee successful operation of the wheelchair[lxxiii]. Standard wheelchair tires are sometimes narrow and can sink into soft surfaces, especially sandy areas.

Wheelchairs frequently have metal hand rims attached to the wheels. Hand rims, also called push-rims, allow the user to push the wheels without having to touch the portion of the wheel that touches the ground. This prevents the user's hands from getting soiled when traversing outdoors, especially in muddy areas. There are two major drawbacks to push-rims. First, they increase the breadth of the wheelchair, reducing the ability to navigate tight spaces,

and secondly, the hand rims also add weight to the chair. The addition of handgrips on hand rims adds an extra comfort for the user. These provide a better grip and allow a more efficient angle for propulsion. As a drawback the handgrips further increase the width of the chair and may cause injury to the user if his or her hand is in the wrong location.[lxxiv]

Many wheelchairs use small wheels in addition to the large wheels in the rear of the chair. In several designs the wheelchair uses only the small variety. These small wheels are called casters, because they can swivel. Casters are usually pneumatic or made of hard rubber. Pneumatic casters provide a smoother ride on rough terrain but like any other inflated tire, they can go flat. Hard rubber casters provide greater maneuverability on hard smooth surfaces and cannot be punctured[lxxv]. For assemblies where cost is of great concern, casters from furniture and used equipment can be used although some casters are not strong enough for wheelchairs.

Many different types of wheelchairs are equipped with wheel locks and brakes. While a bicycle type brake could be used in a wheelchair to increase the ability to slow down, the more common wheel lock acts like an emergency brake. Once the chair has come to a complete stop the locks can be engaged and the wheelchair will not move. There are many different types of wheel locks. Two of these types are low-mount and high-mount locks. Low-mount locks are preferred over high mount versions because they tend to interfere less with the user. One of the more desirable versions of wheel locks is the swing-away lock. These locks move out of the way when the wheel is moving and are less likely to hit the rider's hand.[lxxvi]

One form of brake that is not attached to the chair is the parking block. This piece of equipment is a ramped block with a groove in it. The wheelchair tire is rolled into the groove. Since it takes considerably more effort to move out of the block, the chair is effectively locked in place. This method of parking is really only practical if the wheelchair will only be stopped at a few frequent locations.[lxxvii]

The rest of the seat sub-assembly other than the seat consists of the components in the wheelchair that allows the user to sit in the device comfortably. Individual parts consist of the seat, armrests, and the footrests. Only the seat is required to have a working wheelchair, but the other components provide for the different needs of the user, such as the footrests keeping the rider's legs straight.

There are three main types of seats for a wheelchair. Canvas or leather can be stretched between the two appropriate bars of the frame to create the seat, and another piece can be used for the back of the chair. Stretched seats have several advantages over other designs. These seats fit easily into the design of a folding wheelchair because there is no need to dismantle the seat. Because the material's give allows the seat to shape to the user, comfortable positions can easily be obtained without the assistance of cushions or other aids. This flexibility does have its disadvantages though. Seats of this type do not enforce proper posture and can encourage the risk of knee injuries.[lxxviii]

A second seat design uses hard surfaces with cushions mounted on them. While this type of seat encourages a straight back and a correct sitting position, there are many downsides. The stiffness does not allow the seat to be compatible with folding chair designs. In addition, stiff materials used to make the seat are, on average, heavier than leather or canvas so these seats add extra weight to the chair.[lxxix]

The third type of seat consists of a weave. Similar to the stretched seat, this seat is woven material that is attached like a piece of canvas would be. Any flexible material could be used to create the weave; reeds or plastic webbing work particularly good as material for the weave. This seat has many of the same advantages and disadvantages of the stretched seat. The weave is a little cooler in the summer due to the ability to let air pass through it. These seats need to be kept taut and as such do not make very good designs for a folding wheelchair.[lxxx]

The seat of a wheelchair affects the size of the wheelchair and has to be the correct dimensions for the user to be comfortable. Measurements need not be exact but there are some rules that suggest the most comfortable and effective dimensions. The shape of the user sets the width of the seat and it is standard that about half an inch on either side of the rider's hips is left for clearance.[lxxxi] When the seat is too wide, the wheels or push-rims may be harder to reach and the efficiency of movement will be reduced. Seat dimensions affect the size of the wheelchair. Making the width of the seat larger increases the width of the wheelchair, reducing the ability to navigate tight areas. If it is desired that the wheelchair be slightly more stable, making the seat a little wider will help.[lxxxii] The seat cannot be too narrow either. Besides being uncomfortable, the friction on the side of the body can cause pressure ulcers.[lxxxiii]

Depth of the wheelchair seat is also important; there should be about one inch between the knee and the start of the seat when the user is sitting up straight. If the seat is too long, there may be pressure and friction on the back of the rider's calves. The user may place his or her knees in the correct spot and just lean back. This can cause back problems and is generally uncomfortable. When the seat is too short, the entirety of the user's weight is directed to a small portion of the rider's sitting area. This can also be uncomfortable and can cause sores. Some, therefore, have moveable backs so that the depth of the seat can be altered.[lxxxiv]

A final consideration for the seat is the height at which it will sit in the frame. When the user is sitting comfortably in the wheelchair, his knees must be able to easily fit under a table. The Americans with Disabilities Act Accessibility Guideline states that the standard table or other structure where the user will place his legs under should be a minimum of 27 inches above where the feet would be located.[lxxxv] Many people like to raise the height of their seat slightly so they are positioned closer to eye-level with others. If the seat is set too low, the user's feet, or the footrests if equipped on the chair, will not have adequate clearance over the ground and they might get stuck on rocks and bumps.[lxxxvi]

Another sub-assembly of the wheelchair other than the seat is the armrests. To effectively bear the weight of the user's arm comfortably, the armrest must to be at the correct height. If the armrests are too low, the arm is not correctly supported. When the armrest is too high, the shoulder is put in an awkward position, which will be uncomfortable to the user. The armrests must also be situated so that they do not interfere with the user when he or she is rolling the wheels.[lxxxvii]

Many folding wheelchairs have removable armrests. This allows for support of the arms when needed but the chair can still be collapsed into a small space. When non-folding wheelchairs have armrests, they are generally a structural part of the frame and cannot be removed. Some people prefer their wheelchair to not have armrests. The removal of the armrests allows for greater range of movement in the chair and can make it easier to enter or exit the wheelchair. On the other hand, the absence of the armrests forces the user to have a better sense of balance[lxxxviii].

Many wheelchairs come with some type of footrest built into the design. Footrests should keep the knees at right angles and allow the rider to easily maintain, or enforce, good posture.[lxxxix] There should be at least two inches between the ground and the bottom of the footrests. This will provide for adequate clearance from debris or rough terrain.[xc] There are many different designs and each of them has some advantages and/or drawbacks. One common design is the fixed position footrest. These are normally mounted at the correct height for each user. If the footrest is too low, blocks or other supports can be used but there is little that can be done for a footrest that is too high. This type of footrest is the simplest to build, but it sometimes gets in the way when the user gets in or out of the wheelchair.[xci]

There are some wheelchairs that have removable footrests. These normally work like fixed position rests in that they cannot be adjusted, but they can be removed for easier entry. One type of footrest that is very common in advanced countries is the swing-away footrest.

These work like removable rests but they do not detach from the wheelchair. They either swing or fold away from in front of the wheelchair; this is beneficial because they are always present. Some chairs use a simpler route and simply have a board that can be pulled out from under the chair to act as a footrest. Normally there is a box with many slots attached to the bottom of the seat. The board slides into the slot of the correct height to adjust the chair. Straight leg requirements are easily satisfied with this type of wheelchair. The board has to be long enough for the entire leg, except for the foot, to fit. Just one leg can be kept straight by cutting the board in half lengthwise.[xcii]

There are many wheelchairs that do not use footrests. These are ideal for individuals who use their feet to move the chair since the user's feet normally rest on the floor. This may be the only option to a rider who has little mobility and strength in his arms but can move his legs.[xciii]

2.5 Make or Buy Analysis

One of the key concerns when evaluating the appropriateness of high technology when entered into a society is cost, and the best means to analyze production to reduce overall product cost is through Make or Buy Analysis (MBA). Deciding whether to manufacture a part or buy it from any number of locations lies in the calculation of complex figures called direct and indirect costs such as the cost of capital, overhead, and holding costs[xciv]. Minimizing direct and indirect costs and by choosing an order quantity, which finds a balance between ordering and holding costs yields an annual cost for each option so that the most efficient can be selected and a total cost for the product can be obtained. With the MBA this data can be displayed in a graphical and numeric output but there are some limitations to making a decision solely based on this type of analysis that must be considered[xcv].

The costs associated with maintaining a business can be separated into two categories: direct and indirect. Paying employees (labor costs) and material costs all factor into what is defined as direct expenses. Indirect expenses such as rent, loan payments, office expenses, and taxes, are often referred to as overhead[xcvi]. Also included in overhead are startup costs, which are the expenditures incurred when beginning a production run, including things like tool preparation, clean up and maintenance. Another common indirect expense is the holding cost associated with the storing of materials and inventory including the cost of capital, insurance and the renting of storage space[xcvii].

Economic order quantity (EOQ) and economic lot size are mathematical models that assist the user in minimizing the expenses associated with holding stock. An economic lot size is the amount manufactured in a single run of production or the amount purchased in a single order[xcviii]. To buy the right amount of materials or accessory parts, the economies of scale break-even point analysis can be instituted. The unit cost of a product generally decreases as the number of units bought or sold increases. In other words, if more are bought, the part or product becomes cheaper[xcix]. But when an institution holds on to inventory, it holds an opportunity cost equal to the amount of money it could make from investing the money instead of making or buying extra, which will only sit in a warehouse. The unit cost, the reorder cost, and the holding costs sum to the total cost of holding stock. Taking into account all the previous variables, the EOQ uses a formula to dictate the most efficient order number. Some of the assumptions of the EOQ are that we have a single product, that inventory will never decrease below zero, and that the time that it takes to place an order and to receive that order is defined (lead time)[c].

When administered completely, the results of the MBA yield the total annual cost of one part, which can be depicted Graphically or Numerically. Once the total cost of carrying a product is known, it can easily be compared to different options. Selecting the best alternative

is a matter of picking the analysis with the lowest total costs, usually displayed in a spreadsheet. When there are changing quantities associated with an option, a cost verses demand graph is generated for the proposed policy and the profit margin can be observed at the forecasted demands of each possibility. These profit margins are then placed into a spreadsheet or other means of examining lists of numbers, and the option with the greatest profit margin will be determined to be the most cost effective.

Although the calculations of the MBA are accurate predictions based on sound mathematical models, the user of the analysis must make a final decision. The values entered into the analysis are based on accounting figures from the previous year and assumptions for the current year. When trying to forecast how much it will cost to carry a part for one year the results are expected to be slightly off, yet far more accurate than doing nothing at all. Not figured into the Make or Buy analysis's are qualitative values such as quality of part and the reliability of the company. It is up to management to decide the risks and benefits of these variables. Another factor not included is Required Order Quantity (ROQ); this problem can make an option unattainable for a company with a small amount in investment capital. A simple calculation of ROQ multiplied by the cost of the part can be made to establish this value and management must decide whether the option is feasible.

3.0 Methodology

Several steps were necessary in the development of a resource packet to complete the goal of the project. The firsts step included project development and required the team to discover the needs of two organizations, ThaiWheel and the International Support Group, and create a project goal that encompassed both groups' desires. The second step involved conducting and analyzing three focus groups to ascertain consumer satisfaction with the tricycle wheelchair produced by the ThaiWheel factory. The three groups consisted of older Thais, manufacturers of wheelchairs, and young wheelchair users. To complete the third step, which required obtaining resources to give the ThaiWheel organization, contacts were made at multiple government ministries and with different part manufacturers in Thailand. The final step included the creation, testing, and analysis of a program that the ThaiWheel factory could use to calculate the cost of each wheelchair and evaluate options for making parts or buying them from various locations.

3.1 Project Development

Three main phases of investigation were undertaken upon arrival in Bangkok, in order to more clearly define the objectives and goals of the project. Research into the ThaiWheel factory and the International Support Group (ISG) constituted the first phase of research to determine their needs and concerns. Brainstorming of possible projects and research into their feasibility comprised part two. The final phase included the development of a new project goal that would be feasible and useful to both ThaiWheel and the ISG.

A meeting was held with Terayudth Sukonthavit, manager of the ThaiWheel factory to discuss avenues for assisting the factory in its production of wheelchairs. The purpose of the meeting was to determine the largest problems ThaiWheel faces, and how our project might

benefit the organization. From the interaction, it was learned that the most prevalent concern of Khun Terayudth is to produce an inexpensive chair. We discovered that the factory buys expensive parts from Japan and Korea in large minimum order quantities. In hopes to reduce the high initial cost of these large lot sizes, ThaiWheel hoped to get other wheelchair manufacturers to purchase the parts with them as a group.

The second meeting was held with Daniele Lavoie of the ISG in which the ideas, concerns and expectations were garnered from the perspective of those who buy many wheelchairs to give to the disabled of rural Thailand. Through the discussion, we learned of the ISG's uneasiness that certain designs produced by the ThaiWheel factory were not the most suitable for all people of rural areas. Although the tricycle wheelchairs they buy function much better in rural areas than standard wheelchairs, it was their fear that some of the older and younger Thais with disabilities could not properly use the chairs and in some instances, even had to abandon them.

Having determined the principal concerns of both organizations, a stage of brainstorming was begun in which multiple ideas for possible projects were conceived. Some of the ideas we arrived at were to create a training center to teach life and job skills to people with disabilities, to do a cost benefit analysis of expensive imported parts, to help the advertising campaign for the factory, or to assist in the streamlining of the production facility. The different options were derived from the information gathered through our meetings with all parties involved and the strongest options were identified.

The various ideas brainstormed were then evaluated based on feasibility of completion, potential impact, and whether or not they met the needs of ThaiWheel and the ISG. Many of the options were eliminated largely because neither the ISG nor ThaiWheel specifically voiced the need. Siripen Supakankunti, Ph.D., an economics professor from Chulalongkorn University was consulted as a source. Her input initiated a proposal to help ThaiWheel find less expensive

imported parts for their wheelchairs. In her estimation, a specific type of cost benefit analysis related mostly to economics and cost would not only be beneficial to the factory, but could feasibly be finished in the time we had remaining in Thailand.

From the input and research gathered, the original project goal was cultivated and expounded upon to include the needs of both ThaiWheel and the ISG. The goal was to help improve the efficiency and effectiveness of the ThaiWheel organization by conducting a Make or Buy Analysis of a few imported parts and focus groups to ascertain consumer satisfaction. In essence, this goal encompassed the requests of both ISG and ThaiWheel, but further investigation into the MBA would lead to a second, more functional goal. Through the conduction of three target focus groups, consumer satisfaction and the concerns of the ISG could be revealed. With the goal now firmly established, it became necessary to begin the gathering of information.

3.2 *Effectiveness of Tricycle Wheelchair*

In order to assess the functionality of the tricycle wheelchair for the rural Thai disabled community, focus groups of wheelchair-bound citizens were performed. Analyzing the subsequent information into a useful and comprehensive format allowed the gathered data to be used to make concrete recommendations for improvements to the three-wheeled wheelchair.

Focus groups were chosen as the main means of data collection for multiple reasons. First of all, focus groups of about six to eight participants were chosen over individual interviews because focus groups created an atmosphere of sharing and comparing among the members of the group[ci]. In an interview the interviewer is limited to the amount of information that he or she will obtain in a session with just one person. Also, individually gathered results would have been time consuming and had less productive outcomes. The information was of a

constructive, problem-oriented type and was a result of combined and additive surroundings, which tends to happen with larger groups[cii].

The make up of each focus group was determined because of cultural norms specific to Thailand and to ascertain the best results. In Thai culture, elders are very respected and younger Thais might be reluctant to voice their concerns and opinions because of fear that their criticisms might offend the elders[ciii]. Also, it was stated by the ISG that these two groups were experiencing mobility challenges and had unique needs due to the tricycle wheelchair. Focus groups that would result with the most useful information were those consisting of members in the same age category. Therefore, of the three focus groups, one was of older participants and one was of younger wheelchair users. The third focus group consisted of wheelchair manufacturers to uncover useful and informative data from those who make and distribute the chairs.

Before any focus group could be conducted, questions had to be developed that would be inoffensive and guided, yet still allow for open-ended discussion. Questions were worded in a simple, easy to translate manner that would also avoid offending the focus group members, most of whom had disabilities. The sessions were to begin with a greeting by the interviewer that consisted of an introduction and purpose for the focus groups. This was done in order to form a more comfortable setting for the members of the focus groups and to inform them of the reasons as to why they were being interviewed. Introduction questions for the commencement of the focus groups were asked followed by icebreaker questions, off the subject question to get the conversation started. For the remainder of the focus group session, open-ended probing questions were to be asked because more information could be obtained in that manner. The focus groups were guided taking careful notations and observations of non-verbal communication. Prior research conducted on focus groups sessions stated that in a group of about six participants each member would usually speak for an average of about three (3)

minutes. This translated into about a one-hour and a half (1.5 hr.) session[civ]. This was a factor that was also incorporated into the planning of our focus group sessions.

The actual focus group sessions were conducted on Friday, February and Friday, February 14, 2001 in order for the participants to identify the problems relating to the functionality of the tricycle wheelchairs during practical use. The participants were found through the identification of wheelchair receivers in the Pratumthani Province, the Nakomprathom Province, and the Pakkred Province (Pakkred School for Disabled Children) of rural Thailand from the ThaiWheel factory.

The interpreter was an important asset to our research and was provided by the ThaiWheel factory. Because of the language barrier, questions were asked through a translator, and the entire session was recorded for later transcription. The translator was the manager of the ThaiWheel factory, Khun Terayudth Sukontavit and limited the type and amount of responses that were obtained. Due to the fact that our translator was one of the main wheelchair distributors in Thailand the group would likely experience normative response bias. Normative response bias consists of answering a question in a manner that may taint the truth[cv]. With all the data collected from the focus groups, examination of the information was next logical step.

Focus group sessions were analyzed to place the information into a useful and comprehensive format. Data interpretation was done with the use of common tools. Such tools were chosen to keep track of themes and consisted of markers, colored papers, scissors and ample working space. This method dealt with color coordinating each person's response, opinions and concerns. After all the opinions, concerns and responses had been categorized into a specific group they were compared to each other and weighed based on the most common ideas and suggestions. From this analysis, the most general and critical needs that these individuals had were revealed[cvi].

3.3 Resource Package Research

The further development of our project relating to the cost efficiency of ThaiWheel had three parts. The first part included exploration into completion of the MBA and found information, which led to an alteration in the project goal. The development of this alteration into a resource package constitutes part two, while analysis of the usefulness of the resource package makes up the last part of the development.

During the investigation to achieve our original project goal pertaining to a Make or Buy Analysis, new information and ideas were obtained which would alter our final objective. We first began the exploration by visiting multiple government ministries. Although, we did discover extensive useful information in regards to what each ministry does do, none at the time could give all the information we needed to conduct a MBA for the ThaiWheel factory. Research at the ThaiWheel factory gave us many specific statistics about production costs and also revealed some startling information that would alter the rest of our methodology.

We discovered that the ThaiWheel factory does not know the total cost of producing a wheelchair. Because the NPO has only been in existence for a short time and because the major buying of wheelchairs from the factory dictated that ThaiWheel not worry about cost but rather focus on making a good wheelchair, the organization has never take the time to figure out the total cost. It was also discovered that the managers at the factory wanted to know these figures but did not have time to learn the proper practices and conduct an accurate appraisal. Now that ThaiWheel is looking at other means for obtaining parts to reduce cost, we decided that it was important for the factory to be able to make the decisions on whether to make or buy parts and calculate the total cost for its wheelchairs.

After learning these facts, and brainstorming ideas, we decided to make a resource package for the ThaiWheel organization with all the data we had collected and which would demonstrate future options while making the decisions for each of these options easier. The

resource package would contain all the contacts made as well a list of possible manufacturers obtained thus far. It would also contain a program, which could do a Make or Buy Analysis and calculate total cost of parts and wheelchairs. The final part of the package would be specific example with real numbers obtained earlier from ThaiWheel to demonstrate the usefulness of the program and discussion of future options to demonstrate the usefulness of the package as a whole to the ThaiWheel organization.

3.4 Development of Program

After the project group finished analyzing the findings from ThaiWheel and generated a general design for the application to perform the make-buy analysis, many difficult choices about the exact realization of the program had to be made. Implementation plans needed to be created in a particular order, highest level decisions first, slowly progressing to the lowest. Selecting a programming language and dividing up the functionality of the application were two of the first choices to be made. Next, the second tier options, including database use, report design, and algorithm generation, had to be weighed. After all of the more encompassing selections were made, the low level decisions had to be analyzed pertaining to aesthetical placement of the different controls on the screen and providing a means of data verification.

High-level decisions normally start off with selecting a programming language, of which the project group chose Visual Basic 6 (VB), a program development platform from Microsoft. It was carefully selected because after all of the different options were analyzed it was determined that many of its key features would assist the creation of the program. Rapid development of Windows applications along with the ease of building effective and user-friendly database interfaces were two of the first benefits considered by the group. Other programming languages require substantial amounts of code for even the smallest Windows or database programs while VB offers a "point and click" method of generating a working project.

Another reduced code feature of the programming language is the creation of a graphical user interface (GUI). Similar to an interpreter, the GUI is what the users interact with to effectively use and understand the code and data in the program. The last critical feature that convinced the project group that VB was the correct choice was the ability to generate different forms of reports without the assistance of third party software. Since this additional software is both expensive and not guaranteed to be on the user's computer, not relying on its services makes the program more robust and distributable.

Having already selected VB, the second high-level decision dealt with the different purposes of each component of the program and how to separate each section into logical components instead of displaying the entirety of the application on one screen. There were several benefits to this course of action, the first consisting of intuitively separating functionality for the user. If one area of a program contains too many features, the user can become confused and not understand how to operate the application. A second benefit was partitioning of the code, which is a set of directions informing the computer how to respond to the user and other forms of data. While the program may not look complicated and involved to someone who is computer savvy, there are large amounts of code behind the GUI, invisible to the user. Being able to logically divide the set of instructions can greatly reduce the complexities in generating the application.

After the basic structure of the program was completed, mid-level decisions pertaining to specific features such as database implementation had to be made. One of VB's principal selling points is its ability to allow the programmer to create complex database applications quickly and with minimal code. Because it is so feature rich, care had to be taken to select the most appropriate database tools. The data access object (DAO), which is simply a means of accessing and using a database, was chosen for two reasons. First, because of the regularity with which it is used, the project team was already familiar with its more intricate parts.

Secondly, the DAO was selected because it provides the easiest and fastest development, avoiding complexities not required by the application being written for the project.

Another important post top-level feature that had to be considered was how to display the different report formats required by the program. Since there were four different types of displays, several separate methods would have to be employed. Because one of the output formats was to simply print the contents of the database as text, a rich text box (RTB) was selected. The benefit of a RTB, which is a box that contains formatted text, is that it can easily be filled with the desired data and printed without the need for complex code. Due to the remaining reports comparing data between different wheelchair components, a different means had to be identified. While three outputs remained, they consisted of two types, spreadsheet and graph. A Microsoft Flex Grid (MSFG) became the component to help generate the spreadsheet. This object, while similar to a multi-functional spreadsheet, required some coding to populate but still less than if the entire report was generated in code. The last two data reports called for a graph that could be updated at run time, when the user is running the program, and provide several different plotting methods, such as a bar or line style. Only the Microsoft chart object was found to be able to both meets these requirements and have the ability to interface to the database chosen for the program.

The last medium option that had to be considered was how to create an appropriate method of computing the make or buy analysis. A combination of different sources was utilized to setup an effective and simple set of equations and relationships. One reference source consisted of several different economics textbooks which displayed classical economics and large amounts of theory used to generate the various outputs. The second source was Professor Siripen Supakankunti from the Chulalongkorn University. She was able to provide the project group with practical information about different forms of economic analyses and

how to proceed with the project. These various sources were synthesized into a manageable set of equations the program could use to compute the analysis.

After all of the higher-level decisions have been made, the base level choices and actions have to be considered. While their effects are not as wide sweeping, these decisions are equally important to the overall satisfaction of the user and the total quality of the application. Placement of the different components in the window can change the public's opinions of the program. If they are not presented in a logical manner, unnecessary confusion could be introduced and the user may feel that the program is not a high quality, professional product. The result would be an unsatisfactory product that would hardly be used, despite all of the possible benefits from using it.

Another low-level decision that is critical to improving user satisfaction that had to be made was how to include a comprehensive data verification system. The project group decided that this program needed a two-part arrangement. Because navigating between different portions of the program is easy, a means to prevent the user from forgetting to save the current database record had to be generated. After comparing several different options, it was decided that providing a prompt for the user when the case arose was the most advantageous. Analyzing the user supplied data for invalid values, such as "0" when that variable will divide another variable, comprised the second portion of the data verification system. This section worked in two sub-segments. First, characters that would always result in an invalid entry were not allowed to be entered. Secondly, when the program starts using the economic equations, all of the inputs are tested and the program stops the analysis if any of the pieces of data would cause an error.

4.0 Results and Analysis

Raw data was compiled during the methodology from a multitude of sources and had to be compiled, organized, and analyzed in a manner from which conclusions can easily be drawn and recommendations be made for future improvement in the efficiency and effectiveness of the ThaiWheel factory. The results obtained from the conduction of our methodology fell into two categories. The first category of results involved the needs of the wheelchair users and ThaiWheel, while the second involved the actions we took to address the needs of ThaiWheel in the form of a resource package.

4.1 Needs Assessments

Obtaining information about the needs of ThaiWheel and their product users are essential inputs to acquire the knowledge necessary for future improve the effectiveness of the product. Two different forms of needs assessments were conducted in order to obtain this information. The needs of the user were obtained through three target focus groups with wheelchair manufacturers, disabled users of the tricycle wheelchair, and young Thais with disabilities. To better assess the needs of the ThaiWheel organization, informal interviews were conducted with the managerial staff at the factory.

4.1.1 Needs of the User

Information obtained through the focus groups ranged from suggestions to add umbrellas and cup holders to the tricycle wheelchair to problems such wear and tear on parts. The information was organized into findings by the strength of agreement by the group and strengths and weaknesses of their known experience. For example, the responses by the wheelchair manufacturers about the original intention for the use of the tricycle wheelchair were weighted more heavily than the responses of the children to the same question. From this, our

findings from the target focus groups were placed into four major classifications. The first group of findings related to general use of the tricycle wheelchair including who it was designed for and in what situations the tricycle wheelchair is usually found. The second classification dealt with common problems the users had with the tricycle wheelchair. Suggestions for future tricycle designs made up another category of findings developed from the focus groups and specifics dealing with use by children and the elderly made up the last.

General Tricycle Use

From the focus groups, the typical use of the tricycle wheelchair was developed. The intended and most common use for the design is outdoors for distance travel over roads or in rural areas. The manufacturers agreed that this was the original intent of the design and backed up the declarations made by the users. Both also said that because of maneuverability problems, use of the tricycle wheelchair in most indoor settings was extremely hard. All the manufacturers in the focus group and users tended to agree on these points being fundamental and inherent to the tricycle design.

The intended users of the tricycle wheelchairs were developed from the focus group sessions and did not include children or the elderly with disabilites. According to wheelchair manufacturers and users of the tricycle design, the tricycle wheelchairs were not designed for toughness in travel or with children in mind, and are therefore too heavy, bulky and large for use by those particular users. Typically, children are small in stature putting major physical restraints on the size the chair can be.

Tricycle Problems

Although many problems were mentioned during the focus groups, the problems most stressed and agreed upon by the group included the pumping, the lack of proper brakes and spare part problems. The three-wheeled design has a level that when pumped back and forth

turns the wheels much in the same way a locomotive does (see section 2.4.2). The group of tricycle users established that to start that pumping required significant strain and was difficult to do. Multiple members also stated difficulty when entering an exiting the tricycle wheelchairs. The only brakes on the tricycle wheelchair are the typical bicycle style squeeze brake and no parking brake is standard, so the members reported that the chair rolled when trying to get in and out. The third largest problem that was mentioned by most of the participants was that spare parts were difficult to find. Because the wheelchairs are used every day for travel and use, wear and tear occurs rapidly, but parts to replace those that have worn out are not readily available.

Despite possible bias, the group spoken had first hand experience and knowledge that flowed freely once initiate. For answers to questions regarding everyday problems with the tricycle wheelchairs, the people to ask for the first hand account are the users. The adults with the three-wheeled design in the focus group all had many years of experience using the product and new others who used them as well. Once the discussion began, talking commenced about difficulties with the chairs, despite fears that the interviewer would cause normative response bias, due to the fact that he provided different members with their donated chairs.

Suggestions by Users to Tricycle Design

The tricycle users and the wheelchair manufactures also had many opinions about how the tricycle wheelchairs could be altered in future designs to better suit their needs. The hope of the wheelchair manufacturers is to, in the near future, address the problems with regards to size, mentioned earlier by focus groups participants. It was therefore, agreed to by all, that future wheelchairs should be smaller and lighter to allow greater mobility. As a solution to the problem of entry and exit rolling expressed early, the suggestion was made by multiple group members to add a parking brake to the tricycle wheelchair much like the ones currently standard on regular wheelchairs.

Another idea that arose indirectly from the focus group discussions was that no one knew simple solutions to the problems the old and young had with the tricycle wheelchairs. Although questions were asked about possible suggestion and alterations to better suit the old and the young, no feasible solutions were readily available. Simply put, the size and the strength needed to move the chair make it tiring for many adults to use, let alone children and weak older Thais with disabilities.

Children and the Tricycle Wheelchair

Findings from the focus group with children yielded information regarding the experience the children had with the tricycle wheelchair, what the problems are with the chairs they had, and whether they would prefer standard or regular wheelchairs. To find out about the children and the use of the tricycle wheelchair, the most obvious source of information is the children themselves. They know best whether they could or could not use the tricycle wheelchair and what the best solution may be.

The use and desire for a tricycle wheelchair by the children was limited. None of the eleven young students were currently using or own a tricycle wheelchair. When asked what they would prefer if offered either a tricycle or a standard wheelchair, 8 out of 11 said that they would choose a regular one because they would use it more. Of the others that wanted a tricycle design, most of them wanted them to play with, as a toy, outdoors. The students also agreed that they spend most of their time indoors and do not do a significant amount of distance traveling that might warrant the need for a three-wheeled design.

4.1.2 Needs of ThaiWheel

Continued research into the needs of ThaiWheel was conducted through informal interviews with the managerial staff of the factory. Through several sessions, findings were gathered on multiple aspects of the business and helped give true insight into what the company

truly desired the most. Numbers and figures to use in the analyses and information about what the factory needed most were garnered from these interviews.

The other findings were related to the general accounting of the ThaiWheel organization. Currently the total cost of producing one wheelchair is unknown. Prices are arbitrarily set to around the industry standard, but whether profit or losses are being obtained from these set prices is also unknown. Because of the complicated nature of finding the total cost of each wheelchair, help was needed.

Also, the time required to make these calculations and accountings would be substantial. Time is a precious for any organization and a small factory with few personnel would see this first hand. For one person to take the time necessary to look into scenarios, find possible part manufactures, make decisions of whether to make or buy a part, and to calculate the total cost of the wheelchair would take months at best. With so many things to do, and few managerial staff, we found the ThaiWheel factory in need of aids to increase the expediency of those projects.

4.2 Resource Package

Results and findings relating the cost efficiency of the ThaiWheel factory and the future opportunities to expand and improve production are presented in a resource package. The package is made up of two major parts. The first major element of the package is made up of two tools for the evaluation of future options, which includes a program to conduct a Make or Buy Analysis and find the total cost of the wheelchairs produced, as well as manufacturing contacts. Examples of the programs use with real numbers and discussion of future options and avenues for development make up the second key element of the resource package. The functionality of the resource package is retained in the second half of the package, within the scenarios and future options. The executive summary is added to the package as well, so that

future users or viewers of the resource package will know the validity of the results and the means for development of the resources.

4.2.1 Tools

Two tools that are used in the creations and implementation of future options are the Economic Analysis and Total Cost Program, as well as contacts in both government and manufacturing. As a result of earlier findings involving the needs of Thai Wheel, the first tool or the program, was tailored to specific ease of use by its managers. The second of the two tools includes multiple government ministry contacts for the industry in Thailand and a list of local manufacturers who may be able to produce parts domestically that ThaiWheel currently imports from Japan and Korea at high costs.

Program

The first tool found in the resource package, which is called the Economic Analysis and Total Cost Program (EATC), allows the supervisor of the ThaiWheel factory to find, even after the project group has left, the cost of parts used presently and in the future in addition to the total cost of different wheelchair designs. The EATC Program design was tailored to meet the previously discussed needs and desires of the organization. For example, ThaiWheel is presently seeking ways to reduce the cost of their wheelchairs and the project group came to the conclusion that the one of the most effective and sustainable methods would be to reduce the cost of the wheelchair's constituent parts by utilizing the Make-Buy analysis to find more advantageous component acquisition schemes. Additionally, ThaiWheel management expressed the desire to accurately know the cost of producing one wheelchair, requiring the program design to change to encompass this extra feature. Another design requirement placed on the program was the introduction of a database to save all of the different options and inputs the user provides to prevent repetition and increase efficiency. Since the application would not

have been that useful without an easy way to compare the outputs from the program, a report generation element was infused into the design.

A program was created that would allow ThaiWheel to execute the make-buy analysis without the assistance of the project group. The main reason for this was sustainability, one of appropriate technology's critical components as described in the literature review (2.2 Appropriate Technology). Since Thailand's economy is rather fickle, dramatic changes can occur in short periods of time, so the program would prevent the project from becoming outdated and obsolete. Since acquiring correct and up to date economic information is a very difficult task, the program would enable ThaiWheel management to analyze information as it became available. The difficulty of gathering the data lies in the fact that the knowledge of which parties to correspond with and the ability to navigate any information sources appropriately is crucial but also regional and difficult to learn. Language barriers, coupled with our inexperience working with Thai manufacturing companies, greatly reduce the flow of beneficial information forcing any analysis of future options for the organization to be imprecise and misleading. Only analyses using data researched from ThaiWheel's supply of knowledge would be appropriate for any form of recommendation. The supervisors, who work for a manufacturing organization, are better equipped to obtain any future information and have the ability to continuously update the collection. Therefore, the program would be able to constantly provide accurate cost information for ThaiWheel using the data acquired from the managers at the NPO.

ThaiWheel expressed a need for an easy to understand method to improve its efficiency, requiring the program to be both intuitive and non-time consuming. To maximize the robustness and overall usefulness of the application, great care was taken to add features that significantly contributed to the level of results and eliminate extraneous additions to prevent the program from becoming convoluted and confusing. As shown in Figure S1, the program

reduces clutter and brings the more influential variables to attention on the analysis screens by only displaying the key inputs and outputs. Total annual cost of the parts, which is the complete cost for one year's worth of parts, and the total cost of one part, being the cost of one part with all additional expenses such as ordering costs and holding costs, had to be displayed since these are the two outputs which show the real cost of the part. Other important outputs such as holding cost and ordering cost were displayed, allowing the user to get a better understanding of the nature of the additional expenses. Outputs of lesser significance are not revealed to the user and the inputs that rarely change are modifiable on a different screen. In order to remove some complexity, the make analysis and the buy analysis where separated into two different sections. While many of the variables and equations in the two analyses are similar, there are some differences and not making this point clear could be a frustrating source of puzzlement.

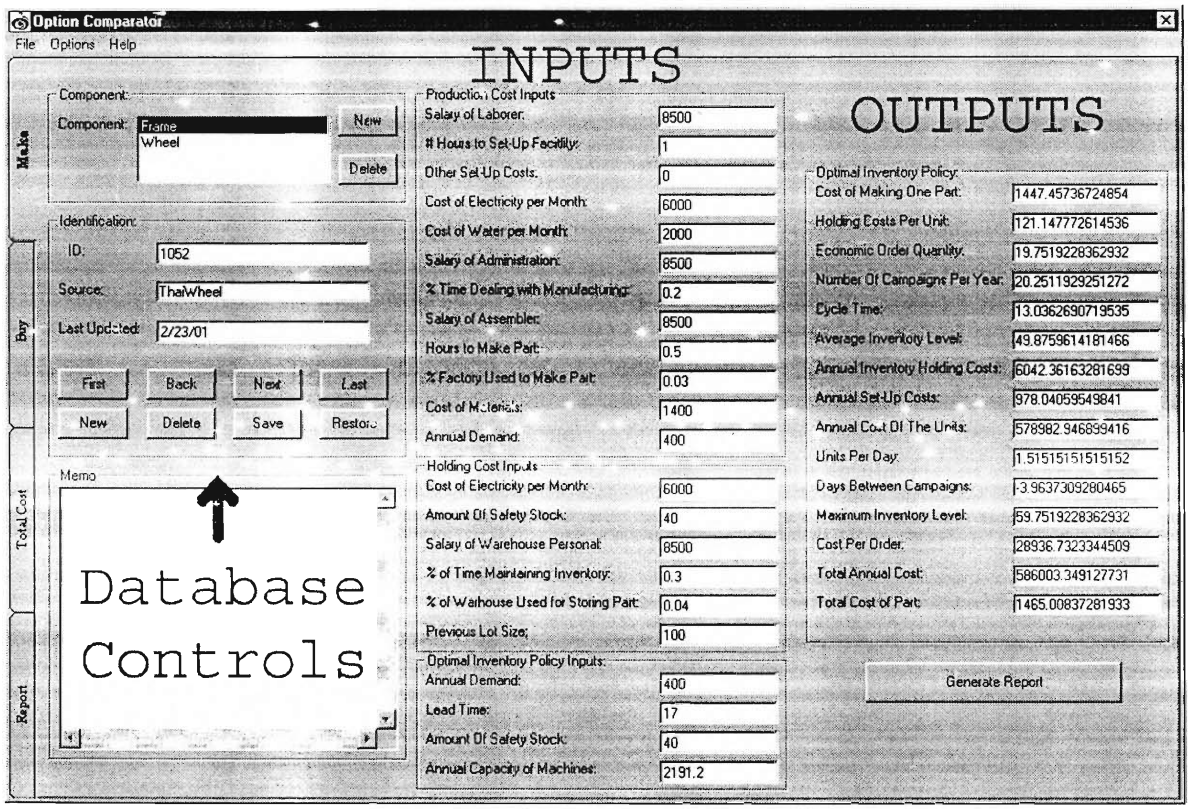

Figure S1: A make analysis screen shot showing the orderly placement of key inputs, outputs and controls.

After learning of the managers of the NPO's lack of spare time to dedicate to the program, it was decided that a database had to be incorporated to prevent the user from needing to reenter all of the data each time the application is used. Since each policy requires over twenty-five different inputs to be entered for the complete analysis to take place, removing redundancy can significantly reduce the required time to use the program. The database makes viewing multiple policies simple because the user can save the policy that they are working on and then move to another record, coming back to the original later. Another feature is the removal of the need for a hard copy of the different policy options. Despite the fact that always maintaining a current hard copy is a recommended practice, needing its assistance for every use of the program can become tedious and induce data entry errors.

Because of the finding that ThaiWheel is presently unable to find the cost of ThaiWheel's current and future wheelchair designs, this functionality was included in addition to the make or buy analysis. It was decided that this section of the program would allow the user to select which methods and companies provided the parts used in the wheelchair. Chosen parts would be entered into a spreadsheet type display, creating a bill of materials, similar to a wheelchair ingredients list. Maintained at the bottom of the form, the updated cost of the part is displayed to the end-user. There is a second step to computing the total cost of the wheelchair, since this section only finds the total cost of the parts, this figure must be entered into the make analysis section to acquire the full cost of not only gathering the parts for the wheelchair but also building and storing it.

While the previous sections of the program are helpful by themselves, the application had to be able to generate different types of reports so the user could easily view and compare the outputs of the program. Because of the diverse functionality and uses of the program, we decided to implement four different types of report. The first variety chosen does not compare the different policies but simply prints out each in its entirety for the selected component. This

provides the benefit of both having a hard copy of a portion of the database and also being able to analyze the policy off-line. Due to the comparative nature of the program, the remaining types of reports were decided to contrast the separate policies in different manners. A spreadsheet style analysis was chosen as the second report to be implemented, allowing the user to appraise each policy using the total cost outputs. Graphs were implemented also because of the fact that they allow easy comparisons against many options and different users may find these more intuitive then the spreadsheet. While the graph can be converted into several different types, such as a bar or line graph, two different types of data were chosen to be plotted. The first version simply charts the total cost of one part for each policy of the selected component. Another form of analysis, shown in Figure S2, is introduced with the second version of data. While the first graph style simply plotted the output using the user supplied annual demand, this latter variety sweeps the annual demand to demonstrate how the number of parts acquired by the company each year can have a large effect on the final cost of the part.

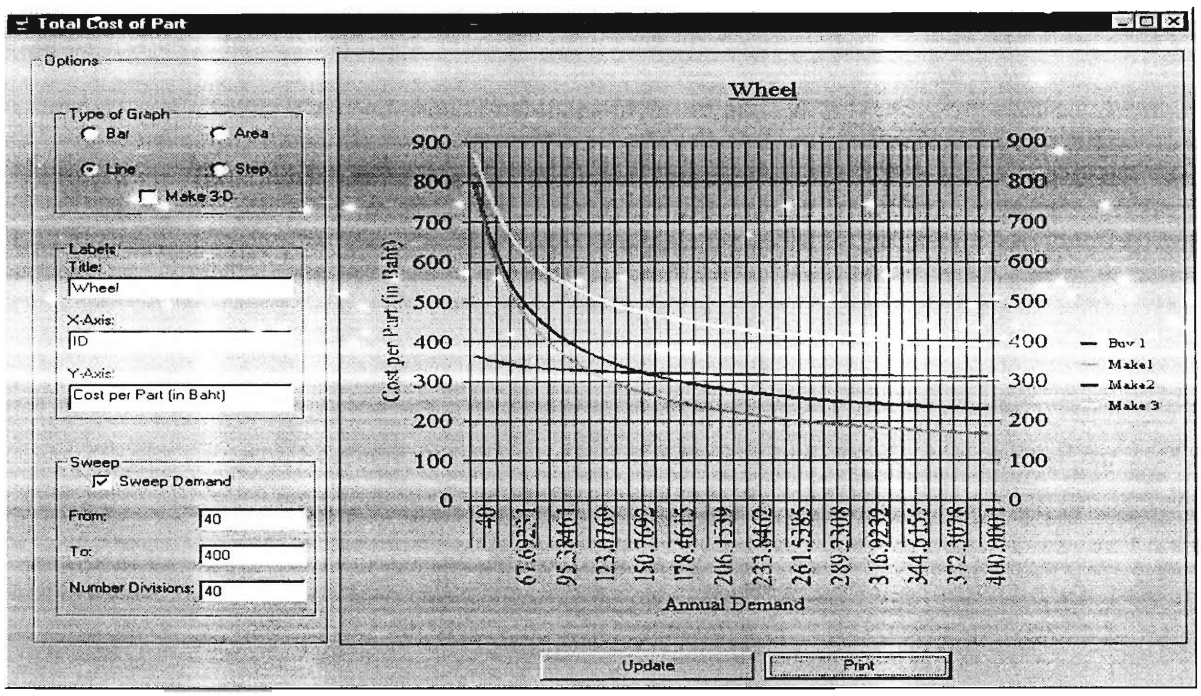

Figure S2: The second graph variety showing an example with a swept annual demand.

Contacts

The three most important government contacts include individuals at the Ministry of Industry (MOI), the Board of Investment (BOI), and the Ministry of Commerce (MOC). The Ministry of Industry helps local manufacturers in Thailand find other local manufacturers to improve domestic production. Kun Krisada Israngkul Na Ayudhya at MOI can be of great help in the location of possible part manufacturers for the ThaiWheel factory. From the limited interaction we had with MOI, a large list of possible manufactures was obtained, which must be further investigated to discover specific factory capabilities. The contact at the Board of Investment can help the ThaiWheel organization find funds for internal growth. The BOI finds foreign investors to pay for industrial growth, which could aid ThaiWheel when buying new machines to start new, in house production of other wheelchair parts. The job of MOC is to find foreign nations to export Thai products to and could possibly assist the ThaiWheel factory in selling parts produced in excess.

The usefulness of these contacts is that the supply of information is not limited. Each of the contacts mentioned has large amounts of knowledge and information at their fingertips and can give ThaiWheel leads and direction for all future avenues. Value also lies in the fact that each of the contacts at each ministry has shown a true desire to help, and may prove invaluable during future endeavors.

4.2.2 Uses

The resource package has many uses for the ThaiWheel organization, but two types of examples were chosen to show the possibilities. The scenario is a specific example of a brake that is currently bought from Japan but which can be purchased in Thailand, with real numbers found from the ThaiWheel organization input and analyzed. In the future options section, out of

limitless possibilities, three were chosen to best illustrate what can be achieved when using the packet and resources found within it.

Scenario

Actual data from the ThaiWheel Organization was entered into the Economic Analysis Total Cost (EATC) program to illustrate the capabilities of this type of analysis. This program allows the user to enter economic data, makes necessary calculations, and displays important outputs that aid ThaiWheel in difficult decision making situations. There are some qualitative values that are not considered by the MBA that must also be analyzed by the manager.

The program starts by giving the user a place for entering source and economic data specific to each part. In our example the costs associated with buying a brake assembly from two different sources are being compared. Direct and indirect costs (Section 2.5) for each part were first entered into the buy analysis section of the program (Figure 1).

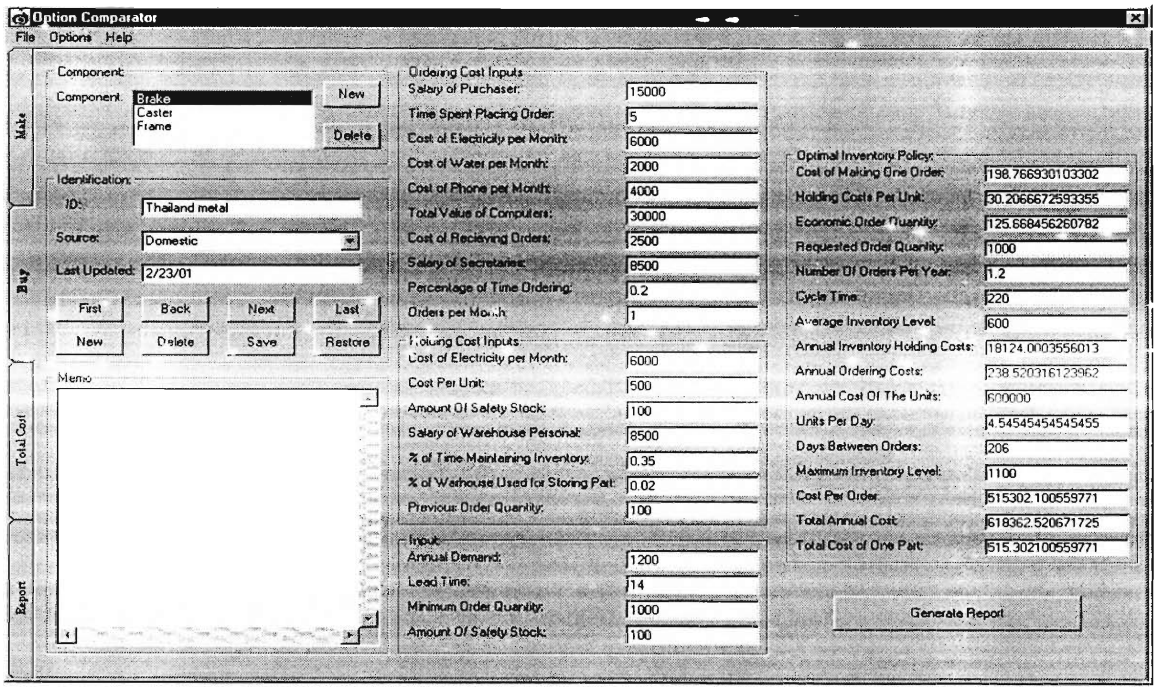

Figure 1: The input page has eight major features within three columns. The first is used to enter source information and the second is for economic inputs, while the third shows outputs calculated by the program.

Column one is made up three subcategories pertaining to ordering and classifying the part. The Component section allows the user to create new part categories and select any of the components previously entered into the program. The Identification area is used to assign unique details about the part and will be displayed on the reports generated by the program. The Memo space can be filled with any useful information that has not been addressed by the report like phone numbers or a contact person.

The second column allows the user to fill in economic data about the part in question. Ordering costs are expenses associated with repeating an order. Some of the costs related to Reordering are labor (drawing up an order, computer time, supervision), receiving costs, equipment depreciation costs, transportation, and movement costs. The reorder costs can be determined by dividing the total annual costs associated with making the orders by the number of times that the part was ordered that year. Holding costs is the costs of holding an item for a period of one year. These include the indirect costs of capital (opportunity costs), storage space, loss (pilferage), handling, administrative, and insurance costs. These costs are figured by taking the value of the stock and adding the indirect costs then dividing it by the average inventory held over one years time.

Column three contains the Optimum Inventory Policy, which has calculations made by the program to find the lowest overhead for each part. Some of the major factors are Economic Order Quantity (EOQ), the total annual costs of ordering, holding, and total price of part. All of this information can be used to decide if an option is advantageous and/or feasible for ThaiWheel.

EOQ is a mathematical model, which assists the user to minimize the expenses associated with holding stock. It takes into account all of the previous variables reorder cost, holding cost, and unit cost then uses them in a formula to dictate the most efficient order number. Some of the assumptions of the EOQ are that we have a single product, that inventory

will never decrease below zero, and that the time that it takes to place and receive that order is defined (lead time). The total annual costs of ordering, holding and price of the parts are calculated and added together to find the total annual cost of carrying this item. From this the total cost of holding one part for one year can be identified.

The program automatically performed calculations after the data was entered and two outputs were produced to show the information in within visual aids (Table 1 and Figure 2). Important comparison factors can be viewed in the spreadsheet and graphical representations of the part.

ID	Source	Total Annual Cost	Total Cost of One Part
Denso	Import	982818.1	819.0151
Thailand metal	Domestic	618254.5	515.2121

Table 1: A screen shot of the spreadsheet, which compares the total annual cost and the total cost of one part from two different companies Denso and Thailand Metal.

The information on Thailand Metal Co. was taken from inputs seen in figure 1, similarly information was gathered on Denso Co. (not shown). Our program derived total annual cost and total cost of one part and has produced a spreadsheet for an easy comparison. Total Annual Cost shows how much it will cost ThaiWheel to buy and store the parts for one year and Total Cost of one part represents the actual amount it will cost ThaiWheel to hold each part. Viewing Table 1, one could deduce that buying the part from Thailand Metal Co. would be more advantageous than buying from Denso Co. in a purely monetary analysis.

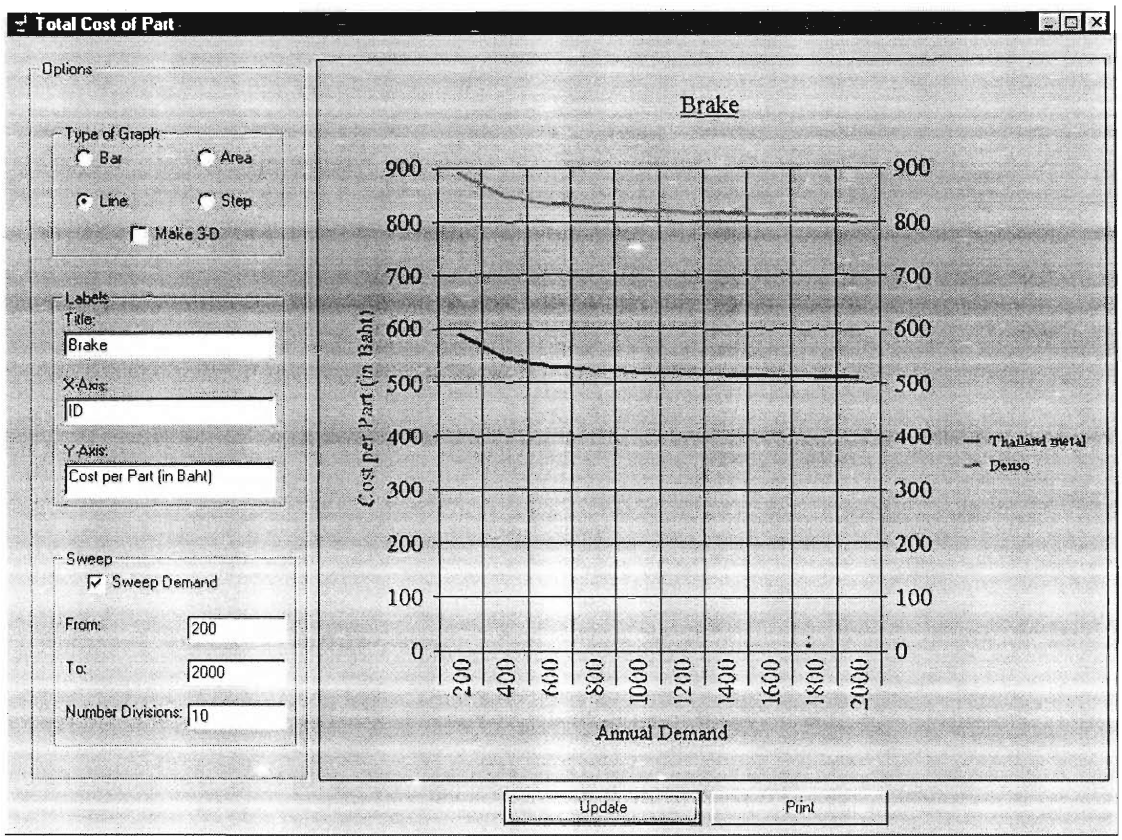

Figure 2: A screen shot of our graphical output shows how the user can choose different types of graphs, pick the part category to be compared, and the sweep of the annual demand. The actual graph shows a total cost per part as per a variable annual demand.

Our graphical representation displays a variable cost on the vertical axis over a changing demand on the horizontal axis to help show the cost benefits of using larger quantities per year. Since the ordering costs and the holding costs are the same for each option the total cost for each part are independent of quantity. Further more, from observing the graph it can be seen that the total cost of the parts does not drop off much after the demand reaches 900, this would indicate that as long as the demand stays over that amount savings are limited. In ThaiWheel's case they currently require 1200 brake assemblies each year and the graph reflects that amount.

Results from the MBA performed by the EATC program are valid aids in deciding whether or not to pursue a new supplier or not, but they are not the only factors that play into that conclusion. As shown by the visual aids, the costs of the domestic supplier's parts are

much cheaper. Not figured into the Make or Buy analysis's are qualitative values like quality and the reliability of the company. Similarly another factor not included is required order quantity. In this scenario the domestic company requires that ThaiWheel purchase at least 1000 units. That would last ThaiWheel for ten months and the initial investment would be B500,000 but a return on investment of 37% is very appealing for any company. Keep in mind that this is a prediction of the total costs to ThaiWheel, the information is based on data from previous years and current prices.

Three Future Options

To demonstrate and further explain the utility of the Resource Package, we analyze three paths ThaiWheel could follow. In the first path, ThaiWheel chooses to keep their current dealer or switches to a new supplier. The second option could be to produce the part for themselves and maybe even produce a surplus of the parts to sell to other wheelchair producing companies and wheelchair part distributors. A third path for Thai wheel to follow includes the option of becoming a wheelchair part distributor either from producing a surplus of parts or from buying a surplus of parts and selling them to other interested parties

ThaiWheel's first option includes whether to keep their old supplier or to find a new foreign or domestic supplier. Assistance in finding new options to buy parts from can be found through the MOI. ThaiWheel can view these options on their website, www.oie.go.th, or through the contact person at the ministry itself. Once found, the new producer could be asked to offer information necessary to update the EATC program and find the total cost of the part. Vital information may include the minimum lot sizes required, the lead time, and the per part cost, all of which can be entered into the EATC program. The calculated outputs seen in table 1 and figure 2 can be observed to decide which option is the least expensive. Undetermined qualitative variables will play a role in the final decision, however. Does the new supplier have

the same quality of part? Will they meet the deadlines necessary for ThaiWheel? Does the order quantity exceed the amount ThaiWheel is willing to buy? A reliable decision can now be made as to what direction ThaiWheel and its suppliers will take.

The next scenario gives ThaiWheel the ability to evaluate the costs and benefits of manufacturing the part themselves. This includes making enough parts to supply their own company and making a surplus of those parts in order to sell them to other consumers. Investigating this option requires using the government agencies and the program from the Resource Package. MOI could be contacted in order to find companies willing to supply the raw materials or subassemblies needed to make the part. Furthermore MOI and MOC could assist ThaiWheel in finding companies willing to buy any surplus parts produced. In order to produce a part ThaiWheel may have to expand their facility and/or buy expensive machinery. If the initial investment were too large for ThaiWheel to handle, then seeking a low interest loan from BOI would be a feasible option. After concluding that producing the part is a possibility, the data can be entered into the EATC program. The output would be compared to previous total cost of the part to find the difference between the two options as seen in table 1 and figure 2. Choosing to produce a part is a complicated decision with relatively large consequences if the venture fails, but the up side is also equally rewarding.

Finally, ThaiWheel has the opportunity to increase lot sizes by ordering parts in a consortium with other wheelchair manufacturers. Due to economies of scale, when order quantities are increased the price of the item usually drops. Investigation into the any cost savings is indispensable since other companies will need to be convinced that participation in such a venture is in their best interest. This alternative also uses many of the resources available in the resource package. BOI can be used to assist in investing in a larger storage area or any other expansion needs. MOI and MOC could be contacted to find purchasers in Thailand as well as abroad. The EATC program is capable of assessing an accurate cost of the part

beyond just the price of the item. The spreadsheet and graphical outputs of the program, as seen in table 1 and figure 2, could be used to confirm the savings associated with purchasing higher quantities as well as to show other companies what they could save. Keep in mind that the actual price of the part may be affected by an increased order size so a new analysis would have to be formulated reflecting the change in price. A benefit of becoming a distributor would be that ThaiWheel could sell parts to the public, something that they aren't able to participate in at this time. A deterrent of cooperating in this manner is the fact that these companies are in direct competition with each other.

5.0 Conclusions and Recommendations

Recommendations and information have been presented to the ThaiWheel organization in a resource packet, which will lead to improvements in the efficiency and the effectiveness of the current wheelchairs produce by the factory. The information was gathered from multiple sources, including wheelchair users, wheelchair manufacturers, government ministries, university professors, and the program we developed. The conclusions and recommendations made are based on this research and will use the knowledge, contacts, and program found in the packet to increase the quality and decrease the price of the currently manufactured product. In the following, each conclusion or set of conclusions is followed by the recommendations and then briefly discussed. Six recommendations are made with the first two inclusive of the future donation strategies, while the final four relate to future ThaiWheel tricycle designs as well as future options for the factory.

Finding from our focus groups revealed that the tricycle wheelchairs are too big and heavy for young children with disabilities, were not designed for them, and were meant for distance travel of which children do very little. Therefore, we recommend that for future donating strategies, groups wishing to buy wheelchairs for children with disabilities should buy wheelchairs more appropriate for the user, in this case, standard child size wheelchairs. While a tricycle wheelchair offers mobility over distances that a child could use to get back and forth to school, there is no easy solution to overcome the difficulties a child has with the tricycle. Therefore, a standard child size chair is recommended, preferred by most children, and will not go unused.

Findings from the manufacturers and adult Thais partaking in the focus groups illustrated that older Thais could not use the tricycle wheelchair because they are too weak to undertake the rigorous pumping action. Because older Thais also spend a considerable amount

of their time indoors where a tricycle wheelchair is too difficult to maneuver, we recommend that for future donation strategies, groups wishing to buy wheelchairs for old Thais with disabilities buy standard adult wheelchairs for indoor use. Once again, despite the usefulness of a tricycle wheelchair for distance travel, with no simple solutions to overcome the difficulties found by the older Thais, a used standard wheelchair is better than an unusable tricycle design.

To address concerns of the user and to improve the quality of the tricycle wheelchair produced, we recommend ThaiWheel add parking brakes and reflectors, while making some spare parts available for retail sale to replace ones that are broken or worn out. The suggestions recommended are directly from the tricycle wheelchair users and address the most important issues they brought to the table in a manner that will not put an extensive financial burden on the ThaiWheel organization.

Findings from analysis of the program, are that calculating the cost of making parts and buying parts, as well as estimating the summation of all these parts into the total cost of the wheelchair is a complex and difficult task. The managers at the ThaiWheel factory want to, and need to, know these figures, but have limited time to spend in this manner. Therefore, we recommend that the ThaiWheel factory enter the information for all their wheelchair parts into the Economic Analysis and Total Cost Program, regularly update the information, and calculate the total cost of each wheelchair. Four examples of have been input using current data acquired from the ThaiWheel organization, but are subject to change and should be regularly updated. Once all the parts have been input, future comparisons and options can be easily evaluated and their resultant effect on final cost can be seen.

Currently, the ThaiWheel factory imports brakes from Japan at high cost, but a cheaper part of equal quality is produced in Thailand. The domestic part though, a brake, has a minimum order quantity of 1000 pieces, which enough to last almost a year of production for the factory and would require the huge initial investment of over 500,000 baht. We

recommend, however, that ThaiWheel find the funds to make the initial investment on the domestic brakes to save up to 37% per year on brakes alone. The savings amounts to over 350,000 baht per year, which could be funneled back into the factory, perhaps towards the in house production of another part.

The ThaiWheel factory has expressed interest in getting wheelchair manufacturers to take part in a group buying venture. To help aid in the development of the venture, we recommend that ThaiWheel use the Economic Analysis and Total Cost Program to demonstrate to other wheelchair manufacturers the opportunities and savings that are possible. Visual aids that stress the monetary savings that could be incurred through the group buying strategy could be present a strong case for other wheelchair manufacturers that may be difficult for them to turn down.

In summary, the goal of the project was to help improve the efficiency and the effectiveness of the ThaiWheel wheelchairs through the creation of a resource package. Efficiency relies heavily on cost. Through future use of the Economic Analysis and Total Cost Program, the cost of the currently produced wheelchairs can be reduced and future options can be demonstrated to improve the efficiency. Effectiveness relates to the functionality of the final product for the user. The results of speaking with current users and manufacturers of wheelchairs led to recommendations for future designs changes and donation strategies to give disabled users a better product. Overall, through cost reduction and improved functionality of wheelchairs for the disabled, we hope that the lives of countless disabled individuals will be improved.

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APPENDIX

Focus Group with Northern Thailand Manufacturer & ThaiWheel (Designers/Manufacturers):

Nakomprathom Province
February 9, 2001
11:00 am - 12:00 pm
Translator: Khun Terayudth Sukonthavit

People speaking in Thai.
Asking focus group members name and location.
Color Key:
Translator
Interviewer
Non-verbal communications

Transcription:

TRANSLATOR: Aneg, he is 48 years old. Where do you live?
TRANSLATOR: In rural area in Thailand.
(Excited to be here)
(Interpreter confused)
INTERVIEWER: In Thailand.
INTERVIEWER: Ok #2, #2 how do you move around, how did you move around before you had a wheelchair?
TRANSLATOR: That someone carry him.
INTERVIEWER: Someone would carry him.
TRANSLATOR: Yes
INTERVIEWER: So someone would carry him to the bed and would carry him wherever he needed to go.
TRANSLATOR: Yes
INTERVIEWER: How did you obtain your wheelchair?
TRANSLATOR: He got himself
INTERVIEWER: He bought the wheelchair himself?
TRANSLATOR: and donated
INTERVIEWER: and it was also donated, so he bought one and the other one...handicapped government registered. So one wheelchair was bought and the other one was donated? Did he buy he's wheelchair or did they donate it to him? Did they give it to him?
TRANSLATOR: Sometime he buy it but sometime someone donate
INTERVIEWER: Ok so, both, it was buying and donating. #3, #4 sorry, on what occasions do you use your wheelchair?
(Hand movements)
TRANSLATOR: he use this wheelchair when she (he) go to bed and....
INTERVIEWER: so he uses this wheelchair, he uses the hand-propelled wheelchair, this wheelchair? He uses a standard wheelchair at home and a hand-propelled wheelchair to move around the outside area. Ok, and for karaoke (laughing). Ask him these questions, #5; they are the same but in a different order.
(not comfortable)

INTERVIEWER: He always has difficulty with his wheelchair? It's not comfortable, ok. Spare parts are not available in rural areas. The pipes break a lot, ok #7.
TRANSLATOR: Are there any times when he cannot use the wheelchair?
INTERVIEWER: Are there any times when he cannot use the wheelchair? When he sleeps or when he's sick? Ok when he's sick.
TRANSLATOR: When the wheelchair break down.
INTERVIEWER: Oh ok. When the ground is too high, when there is a high slope he can't use, or when there are steps he cannot use his wheelchair. Ok. You cannot move into your car.
TRANSLATOR: Too narrow
INTERVIEWER: Too narrow, ok.
(Laughing)
INTERVIEWER: #8 is has he ever used a standard wheelchair? And did he find it easier than the tricycle? Has he ever used a standard wheelchair, is that wheelchair easier than this one (Hand-propelled)?
INTERVIEWER: It depends on the situation so it depends on where he is using the wheelchair. Ok.
INTERVIEWER: Ok so the hand-propelled is used for long distance and the standard for at home, short distance and at home.
INTERVIEWER: So he prefers the hand-propelled wheelchair?
INTERVIEWER: The standard wheelchair is better than the three-wheeler
TRANSLATOR: Because this wheelchair can move around home.
INTERVIEWER: ok so he thinks that the standard wheelchair is better than the 3-wheeler because the standard is easier (TRANSLATOR: yes) to move at home.
INTERVIEWER: It's those questions, these (confusion for Translator:)
INTERVIEWER: oh he did not have a choice as to what chair he could get? No
INTERVIEWER: If he uses the standard wheelchair he can help himself. #11
TRANSLATOR: He bring wheelchair in the car and another wheelchair
(INTERVIEWER: is at home?) yes.
INTERVIEWER: So he has two types of wheelchairs, he has this one (hand-propelled) and a standard one?
TRANSLATOR: Two, yes.
INTERVIEWER: Ok
TRANSLATOR: One problem for old.
INTERVIEWER: One problem for old. He knows one problem for the old it is very difficult or them to move themselves in the wheelchair. Why, why is it difficult?
INTERVIEWER: It is difficult for them to move because the older have less power and they don't know how to use the wheelchair also. Do they have a hard time when they start or is it all the time? When they use the wheelchair at the time?
INTERVIEWER: Is it hard for the elders, older people, do they have less power when the start the wheelchair or when they are using it?
INTERVIEWER: It's when the start? Is it hard from them to take off? Oh it's just hard for them to transfer.
INTERVIEWER: #13, the tires is the most often repair and the bearing, the bearing and the wheel.
INTERVIEWER: The frame also of the chair, the seat, ok. Almost everything
INTERVIEWER: #14
(Finding hard to explain answer)
INTERVIEWER: Does he have any injuries like lower back pain or arm pain?

INTERVIEWER: Very sore. Lower back. He moves down (slides down). Very sore from using the tricycle and driving it fast. He had a bathroom accident.
INTERVIEWER: #15
(Laughing)
INTERVIEWER: #15
INTERVIEWER: Best part, what is the most important part?
TRANSLATOR: The chair, type wheelchair
INTERVIEWER: The type of wheelchair
TRANSLATOR: Material
INTERVIEWER: The material that it is made it especially in the wheels.
INTERVIEWER: Anything else? #16
INTERVIEWER: Make it smaller and lightweight. Ok. Is there anything else that he would like to add, anything else that he would like to say?
INTERVIEWER: There should be some training on how to use the wheelchair and how to maintain it. Before they receive the wheelchair.
INTERVIEWER: And they should have a license? A wheelchair license? *(Laughing)*
TRANSLATOR: He said it serious
INTERVIEWER: Oh ok.

Focus Group Session (Older):

Pratumthani Province
February 9, 2001
3:00 pm - 4:00 pm
Translator: Khun Terayudth Sukonthvit

People speaking in Thai.
Asking focus group members name and ages.
Color Key:
Translator
Interviewer
Notes by assistant- members in the focus group were assigned a number in order to keep track of their responses.

Transcription:
INTERVIEWER: Next question, what is there hobby?
TRANSLATOR: Everybody here not have a hobby. Everybody have a occupation.
INTERVIEWER: An occupation? Ok.
TRANSLATOR: Sell
INTERVIEWER: The sell local products
TRANSLATOR: Lottery
INTERVIEWER: Locally? Oh lottery, lottery. Ok, everyone sells lottery. Ok.
TRANSLATOR: He stay at home sometime.
(Member #4)

INTERVIEWER: 24 year old stays at home sometimes. Where do they live? Do they, um, maybe this will be a better question do they live in the rural areas or do they live maybe in the city?
TRANSLATOR: Rural Area
INTERVIEWER: Rural Area.
TRANSLATOR: Pratumthani Province

INTERVIEWER: What is that again? (Not sure what the translator has said even after Repeating it a second time)
TRANSLATOR: Pratumthani Province. This morning we go to the (some) province and this afternoon we visit the Pratumthani Province (???)
INTERVIEWER: Ok
TRANSLATOR: All people live in rural areas.
INTERVIEWER: Ok they all live in rural areas. So um that answers question #1 so um, down here question #2.
INTERVIEWER: Around the house. Um no, how did they move around before they had a wheelchair?
TRANSLATOR: Climb
INTERVIEWER: They would climb, he would slide.
TRANSLATOR: Slide the body.
INTERVIEWER: Slide your body.
TRANSLATOR: He had to crawl.
INTERVIEWER: he would also climb
TRANSLATOR: Climb. Sometimes house is not available for wheelchair because surface is rough surface, not suitable for wheelchair.
INTERVIEWER: Sometimes they don't have ramps.
TRANSLATOR: No, no ramp.
INTERVIEWER: No ramp. So he would climb.
(#3, #1 and #4 climb)
TRANSLATOR: He had knee injury.
INTERVIEWER: Oh that's how he had a knee injury, from climbing?
TRANSLATOR: Yes
INTERVIEWER: How did they obtain their wheelchair?
(all)

TRANSLATOR: Donated.
INTERVIEWER: Donated
TRANSLATOR: Donated.
INTERVIEWER: They where all donated? All wheelchairs were donated.

Intermission

INTERVIEWER: Um, on what occasions do they use their wheelchair, do they use it for long distance use or do they use it for home, to go to work? It's question #4.
(#2 main speaker, all can drive)

TRANSLATOR: When they go to long distance they pick up the other wheelchair with his car.
INTERVIEWER: Ok
TRANSLATOR: And normally he use the wheelchair at home and the one there.
INTERVIEWER: So they normally take a car to go to work and they take their wheelchair with them but they use their wheelchair at home and at work. Ok. You can drive? Ok, all can drive. #5, do they have any difficulties during daily activities when using their wheelchairs?
(#1 with help from #3, problem with balance)

(#2 slope, #3 overweight, #4 rough area, #5 rural floor, #2 power, #3 lightweight small size, #4 in hospital wheelchair, #2 sport wheelchair, #1, #4, #5 tricycle chair)
TRANSLATOR: He have a accident when he used the wheelchair because he, he no legs.

INTERVIEWER: His legs were amputated.
TRANSLATOR: Yes and the gravity is not balanced, when use wheelchair it turn over from back.
INTERVIEWER: So his wheelchair because he has no legs has tipped over because of gravity. Ok
TRANSLATOR: Yeah, seating is not balanced
INTERVIEWER: Ok it's not balanced.
TRANSLATOR: This is a ThaiWheel Wheelchair.
INTERVIEWER: Yes
TRANSLATOR: He have a problem with the slope.
INTERVIEWER: Ok, he has a problem with the slope areas. Um, is it going up the slope, coming down the slope?
INTERVIEWER: If it's not too incline then he can go up but if it's very incline then it's hard. Ok, alright.
TRANSLATOR: His wheelchair is overweight.
INTERVIEWER: So his wheelchair is too heavy. Ok, too heavy
TRANSLATOR: Difficult for him to transfer when he drive his car alone, he must tell somebody to help him to pick up the wheelchair (to) his car.
INTERVIEWER: Ok so they wheelchair is too heavy and he has difficulty going from his car to his wheelchair. Ok.
TRANSLATOR: The surface around his home is not smooth, it's rock area, he must climb everywhere around his home.
INTERVIEWER: So the surface isn't smooth so he has problems getting around.
TRANSLATOR: Yeah
INTERVIEWER: Ok
TRANSLATOR: He can move his wheelchair around his house. Rural area the floor is not flat and the problem around the stone, the sand…
INTERVIEWER: When he tried to over the rocks and everything.
TRANSLATOR: When he use his wheelchair he must use a lot of power
INTERVIEWER: Ok, is it because it is heavy or because it's hard to maneuver?
TRANSLATOR: Yes. Not…
INTERVIEWER: Is it hard to move it or is it heavy?
TRANSLATOR: Heavy.
INTERVIEWER: Heavy.
TRANSLATOR: All disable want a lightweight wheelchair, and small size.
INTERVIEWER: Small size, lightweight wheelchair.
TRANSLATOR: This is a hospital wheelchair?
INTERVIEWER: Ok
TRANSLATOR: This is a sports wheelchair.
INTERVIEWER: Ok, Do they all these wheelchairs or do they have another wheelchair?
TRANSLATOR: Last question
INTERVIEWER: Oh um, do any of them own a tricycle wheelchair?
TRANSLATOR: 3-wheel motorcycle
INTERVIEWER: So 2 of them own a three-wheel motorcycle and 3 own tricycle.
TRANSLATOR: Only 3 person have a three-wheel
TRANSLATOR: Only one have a car.
INTERVIEWER: Do they have any problems with using the wheelchair when trying to…When they are using the tricycle wheelchair do they have any problems with it, moving around with it?

(#3 when break down, maintenance, wheel and axel, #1 welding)
TRANSLATOR: When the tricycle is break down, in rural area it's hard to find some part.
INTERVIEWER: So maintaining it is very difficult.
TRANSLATOR: The axel of wheel have a problem.
INTERVIEWER: They have problems with the wheel and the axel.
TRANSLATOR: It's not smooth.
INTERVIEWER: The surface is not smooth. The welding; oh the welding where the wheel and the hub, where all that is welded it breaks usually. Ok. They all have regular wheelchairs. Do they find that the regular wheelchair is better than the tricycle? Which one do they like better, the standard or the tricycle chair?
(#1 tricycle long distance, #2 standard home, #3 depends on place, #5 both standard and tricycle)

TRANSLATOR: He loves tricycle wheelchair better.
INTERVIEWER: He prefers the tricycle wheelchair?
TRANSLATOR: Because he can move for long time.
INTERVIEWER: Ok. It's better to use in long distance then to use standard chair. Other prefers the standard chair.
TRANSLATOR: Self help, to use at home.
INTERVIEWER: It's easier to use at home.
TRANSLATOR: Depend on place.
INTERVIEWER: Ok so depending on the place he might like the standard or the three-wheeler. Why?
TRANSLATOR: He love the three-wheeler for he can use the three wheelchair to sell lottery.
INTERVIEWER: To sell lottery. Ok. Um did they have a choice as to what wheelchair they could get? When their chair was donated did they have a choice?
INTERVIEWER: So three of them chose the three-wheeler and two of them chose the standard wheelchair?
TRANSLATOR: Yes
INTERVIEWER: They picked them? They said I want the three-wheel wheelchair or I want the standard wheelchair.
(#1 three-wheel, #2 standard, #3 standard, #4 three-wheel, #5 three-wheel)

TRANSLATOR: Yeah
INTERVIEWER: Ok so they did get to choose.
TRANSLATOR: It depends of they have a chance.
INTERVIEWER: Ok, ok. Um do they know anyone especially the old or they young that have difficulty using the tricycle wheelchair?
(#3 president of disabled organization, eager)

TRANSLATOR: He said that he is the president of Pratumthani disable class. He have experience, the children have a problem with the size of the (standard) wheelchair because it is so big.
INTERVIEWER: It's too big?
TRANSLATOR: Yes
TRANSLATOR: And the children cannot move by themselves.
INTERVIEWER: So they need help when using the tricycle wheelchair because it's too big. Do they use the tricycle?
TRANSLATOR: No, no. Wheelchair (standard)
INTERVIEWER: They use standard wheelchairs, ok. But it's still too big.

TRANSLATOR: In Thailand the same size. Not for children. All wheelchair that donate from the government is the same size.
INTERVIEWER: Ok so all donated wheelchairs for children and adults are the same size?
TRANSLATOR: Not children, not for children.
INTERVIEWER: They are all adult size.
TRANSLATOR: Yes. The elder group want a three-wheel because they can move around.
INTERVIEWER: Outside? So the elders, do they have any problems when they use the three-wheelers, the elders?

Intermission

TRANSLATOR: Most of the elder group have hemiplegia (half body paralysis) they can use one hand and the other cannot use and do not have much power to use.
INTERVIEWER: So the majority of the elders are half paralyzed and they have problem with the power that they need to propel the chair.
TRANSLATOR: Yes because the standard three-wheel not special.
Sandy: Are the able to do full range, can they do this (making hand gesture and confusing the audience)?

INTERVIEWER: Can they reach?
Sandy: Can the easily do the motion? (Confusing them even more)

TRANSLATOR: When they take off is so hard.
INTERVIEWER: It's hard for them to take off.
TRANSLATOR: When for a wide distance, the three-wheel uses lower power.
INTERVIEWER: Ok, what is the most often repair that they have to make to the wheelchair? What do they have to fix the most on the wheelchair?
(#1 tires, #2 casters, #3 seat/brakes, #4 three-wheel hand bar, #3, #4, #5 bearing of axel)

TRANSLATOR: Most wheelchair in Thailand have flat tire. Few air, few air, few air.
INTERVIEWER: So they need to, the tires are the biggest repairs that they make to the chair?
TRANSLATOR: The flat tire, when use all time the tire get off the rim.
INTERVIEWER: The tire gets of the rim. Ok. When used for a long time.
TRANSLATOR: Caster.
INTERVIEWER: And the caster also.
TRANSLATOR: The bearing of caster
INTERVIEWER: Ok, the seat
TRANSLATOR: It tear.
INTERVIEWER: Oh the material from the seat tears off.
TRANSLATOR: And the brakes.
INTERVIEWER: And the brakes. Ok is there anything else that they repair a lot?
TRANSLATOR: For three-wheel the hand is broken.
INTERVIEWER: The hand bar for the three-wheel? Ok
TRANSLATOR: Yes, the hand for three-wheel is broken.
INTERVIEWER: Is there anything else that they have to repair a lot from the three-wheel?
TRANSLATOR: axel wheel.
INTERVIEWER: The axel? It's broken?
TRANSLATOR: Yes.

INTERVIEWER: Ok, um. Do they have any injuries because of the three-wheeler? If they do...
1 trying to catch a car, #2 flipped, #3 flipped with big rock, #4 flipped with transfer, #5 slope "wheelie", brake problems)

TRANSLATOR: All of them have experienced (INTERVIEWER: Injuries?)...Accidents.
INTERVIEWER: Can they name a couple of them, like what type of injuries they have had from using the wheelchair, not the wheelchair from using the three-wheeler?
TRANSLATOR: Yup, all of them have, what kind?
INTERVIEWER: What kind of accidents?
TRANSLATOR: Drunk...(Laughing), drive three-wheel motorcycle to catch other car.
INTERVIEWER: To catch another car (Laughing)
TRANSLATOR: when he from the road he slide, not same level.
INTERVIEWER: Oh the step is not the same level and that's how he had the accident.
TRANSLATOR: It turned over.
INTERVIEWER: Ok, ok. It turns over?
TRANSLATOR: When he get a big stone it turn over.
INTERVIEWER: Ok so when big rocks or something it tips over.
TRANSLATOR: When he transfer himself from the floor to the three-wheel, the three-wheel turn over.
INTERVIEWER: It turns over also when he transfers. Anything else?
TRANSLATOR: When he go to the slope, when he push the power the front tire is over from the road.
INTERVIEWER: So it goes like this? (Making hand gesture) He pops a "wheelie" (smile) when going up the slope. When coming down.

Laughing

TRANSLATOR: The brake is not for moving down slope.
INTERVIEWER: When moving down the brake doesn't work that well.
TRANSLATOR: The brake is not safe.
INTERVIEWER: It's not safe; the brake is not safe when coming down the slope. Um what do they think is the best part, the most important part in the wheelchair or tricycle chair?
(#1 brake system on slope, color black is sad, #2 reflector, #3 compact lightweight chair, hard body and frame, #4 strong, strong wheel and body, #5 hub and caster)

TRANSLATOR: He wants the brake system for three-wheel to stop the three-wheel on the slope.
INTERVIEWER: So the three...the brake, he thinks that the brake is the most important part?
TRANSLATOR: Yes and the color of the wheelchair is much sad.
INTERVIEWER: He wants the color of the wheelchair to match? Too bright?
TRANSLATOR: Black look sad.
INTERVIEWER: Oh so he wants a different colored wheelchair

Laughing

INTERVIEWER: Anything else?

TRANSLATOR: He want to reflect, reflect. The sticker reflect when the car.
INTERVIEWER: Of reflectors, we would want reflectors on his chair. Ok so that when a car comes at night they can see him.
TRANSLATOR: He work in the night.
INTERVIEWER: Ok, a reflector, yes.
TRANSLATOR: He say light weight.
INTERVIEWER: Light weight and smaller.
TRANSLATOR: For three-wheel he want a hard body and hard frame.
INTERVIEWER: A hard body and a hard frame for the three-wheeler.
TRANSLATOR: Make the wheelchair much, much cheap.
INTERVIEWER: Ok
TRANSLATOR: Strong
INTERVIEWER: A strong wheelchair
TRANSLATOR: He want a strong wheel.
INTERVIEWER: Stronger wheel
TRANSLATOR: And a strong body
INTERVIEWER: And a strong body for the wheelchair.
TRANSLATOR: The hub
INTERVIEWER: The hub
TRANSLATOR: and the caster
INTERVIEWER: He would like better hubs and casters. Ok
TRANSLATOR: Because caster is so small when move around the place
INTERVIEWER: Um one last question. What is their idea of the ideal chair? If they could have a perfect chair what would it be? Most important change, if they could change anything in the wheelchair what would they change?
(#5 brakes, #2 parking brakes, #3 special wheel and prevent flipping, #1 roof, motorized)

TRANSLATOR: What part?
INTERVIEWER: Any, anything. If they could make changes to the tricycle wheelchair what would it be?
INTERVIEWER: The brake system. Better brake system.
TRANSLATOR: Brake like wheelchair
INTERVIEWER: So for the three-wheeler he would like a brake like the wheelchair.
TRANSLATOR: When he park his tricycle in slope…
INTERVIEWER: It goes either back or something so a better brake for the three-wheeler more like the standard wheelchair. For parking. Any other changes?
TRANSLATOR: He want a special wheelchair like a basketball wheelchair you know?
INTERVIEWER: Oh a sports wheelchair where he can play basketball
TRANSLATOR: And can protect the turn over
INTERVIEWER: Ok a wheelchair that he could play sports in and that can protect him from turning over. The wheels are more like this (hand gesture)
TRANSLATOR: Yes
INTERVIEWER: The wheels are more on an angle. A roof on the wheelchair for sun light protection. Anything else?
(#3 good material, quality costs, #2 motorized plus manual switchable, #5 wants a box, motorized and signal lights, #3 supply, need to get chairs to people.)

TRANSLATOR: A "cancan" (laughing).
INTERVIEWER: A "cancan" (Laughing), a sunroof. Is there anything else that they

would like to add.
TRANSLATOR: He wants a motorized three-wheel.
INTERVIEWER: A motorized three-wheeler. Is there anything else that they would like to ask, anything else that they would like to say.
TRANSLATOR: Good material
INTERVIEWER: Good material, for the body or for the seat?
TRANSLATOR: Depend on the price. Now the material depend on price.
INTERVIEWER: It depends on the price. Ok
Sandy: Would you rather have a better material at a higher price?

TRANSLATOR: Yes, good quality is more expensive.
INTERVIEWER: Very expensive, yes.
TRANSLATOR: Now the three-wheel depend on the quality.
Sandy: But the average user, would they be willing and able to pay more for the better quality?

TRANSLATOR: He can pay for more quality. The seat of three wheels is made of "bread source"? When sitting for long time the bottom is so hard.
INTERVIEWER: Yes, so maybe something more cushiony.
TRANSLATOR: Yeah.
INTERVIEWER: Better seat. Anything else?
TRANSLATOR: A motorized, for two system, can use power.
INTERVIEWER: So a motorized and manual one. One that you can turn off the motor if you want or turn it on if you wants. Ok
TRANSLATOR: He would like bag, do you know bag. For store accessory
INTERVIEWER: He would like better accessories?
TRANSLATOR: Bag, bag, do you know bag?
INTERVIEWER: Oh a bag
TRANSLATOR: In three-wheel not a bag.
INTERVIEWER: A "lack" how do you spell that, do you know? Like this, something like this, like a box?
TRANSLATOR: Yes
INTERVIEWER: Ok a box. Any other ideas?
TRANSLATOR: If possible a motorized three-wheel and a light weight and signal light.
INTERVIEWER: Oh so signal lights maybe, a motorized um three-wheeler with signal on it so when you turn left and you turn right. Unless there is anything else we are done, those were all the questions.
TRANSLATOR: He have a, now Thai disable people not have a standard wheel...Supply so large, now Thai people not have wheelchair or three-wheelchair because budget of government to buy a big lot to donate to Thai disabled people not enough.
INTERVIEWER: There is not a big enough budget. So what would he like?
TRANSLATOR: Yes
INTERVIEWER: So he would like a bigger budget?
TRANSLATOR: Yes for quality of all Thai people.
INTERVIEWER: So equal rights for disabled people.

Focus Group with Disabled Children:

Pakkred School of disabled
Feb 14, 2001
12 pm- 1 pm
Translator: Khun Terayudth Sukonthavit
8 students
Age: 6-12
Color Key:
Translator
Interviewer

Transcription:

INTERVIEWER: What is your name?
Children introducing themselves
INTERVIEWER: Where do you live? Where do they live?
TRANSLATOR: Pakkred Road
INTERVIEWER: They all live in this Province?
TRANSLATOR: Yeah
INTERVIEWER: Ok, um, do they have a favorite hobby?
TRANSLATOR: Drawing
INTERVIEWER: Drawing, he likes drawing
TRANSLATOR: Planting
INTERVIEWER: She likes planting
TRANSLATOR: And sell the planting
INTERVIEWER: And selling plants
TRANSLATOR: Planting
INTERVIEWER: He also likes planting
TRANSLATOR: fang pen
INTERVIEWER: Listening to music
TRANSLATOR: Yes
INTERVIEWER: Anyone else has any, or just them? How is the ground like where they live? How is the ground like where they live? The area is it bumpy, is it smooth, would they know that?
TRANSLATOR: Flat
INTERVIEWER: It's flat, ok
TRANSLATOR: He go outside
INTERVIEWER: He goes outside
TRANSLATOR: For relax
INTERVIEWER: Oh to relax, ok
TRANSLATOR: Only children live in here
INTERVIEWER: Only children live in this area, #2 how did they move before they had a wheelchair?
TRANSLATOR: Climb
INTERVIEWER: They climb
TRANSLATOR: All
INTERVIEWER: They would all climb, um #3, how did they obtain their wheelchair? Did their parents buy it, was it donated?

TRANSLATOR: Some wheelchair the Pakkred house purchase from outside, the most of wheelchair must donate.
INTERVIEWER: The majority of the wheelchairs were donated but the school purchased some. When do they use their wheelchair? Do they use it for long distance or to use in school and at home?
TRANSLATOR: Only students use around school
INTERVIEWER: Around school, only one person uses the wheelchair for long distance, the rest use them around the school. Do they have difficulties during the day, during daily activities when they use the wheelchair?
TRANSLATOR: She say fall on step and stone and when use the wheelchair to slope, high slope.
INTERVIEWER: So she has problems on the slope and on the steps
TRANSLATOR: and stone
INTERVIEWER: and on the stones
TRANSLATOR: Only Mr. Chaled he go outside, a lot of car
INTERVIEWER: A lot of cars
TRANSLATOR: Some place don't have a ramp
INTERVIEWER: Ok, what are some of the problems that they have when they use the wheelchair?
TRANSLATOR: #5?
INTERVIEWER: No, #6, what are some of the problems that they have when they use maybe moving around?
TRANSLATOR: all students can self help when transfer themselves from the floor to the wheelchair, they have no problem
INTERVIEWER: They have no problem transferring themselves
TRANSLATOR: The size of wheelchair is not suitable for she
INTERVIEWER: For her?
TRANSLATOR: For her, the back of her is not normal; it's big, not suitable for chair.
INTERVIEWER: So she has problems with the seat not being suitable for her body.
TRANSLATOR: Yes
INTERVIEWER: #7, Are there any times that they can't use the wheelchair? #7
TRANSLATOR: Again
INTERVIEWER: #7, Are there any times when they can't use their wheelchair?
TRANSLATOR: At night, when she sleep.
INTERVIEWER: At night, when she sleeps
TRANSLATOR: That's not appropriate
(Laughing)
TRANSLATOR: When she go to the toilet
INTERVIEWER: To the bathroom, when she uses the bathroom.
TRANSLATOR: When they came to the auditorium
INTERVIEWER: When the go to the auditorium
TRANSLATOR: They must climb, because the wheelchair cannot
INTERVIEWER: How do they get to school?
TRANSLATOR: By wheelchair
INTERVIEWER: Does anybody bring them to school, do their parents bring them to school or do they come to school by themselves? By themselves
TRANSLATOR: They can come to school by themselves.
INTERVIEWER: They come to school by themselves. Have they ever used a tricycle wheelchair?
TRANSLATOR: They no use

INTERVIEWER: They have never used a tricycle wheelchair.
TRANSLATOR: Yes, Pakkred home 2 or 3 tricycle
INTERVIEWER: 2 or 3 tricycles, do any of the kids use them?
TRANSLATOR: For big child.
INTERVIEWER: For big kids
TRANSLATOR: no for big child
INTERVIEWER: So for big child?
TRANSLATOR: Yes
INTERVIEWER: Big children. Did they have a choice as to what wheelchair they could get? #10. Did they choose what wheelchair they could get, and adult size or a children's size?
TRANSLATOR: He want a tricycle
INTERVIEWER: He wants a tricycle also.
TRANSLATOR: He want a suitable wheelchair and lightweight
INTERVIEWER: Suitable wheelchair and lightweight
TRANSLATOR: He love wheelchair
INTERVIEWER: He loves his wheelchair. #13 do they have any injuries from their wheelchair?
TRANSLATOR: He have a accident, turn over
INTERVIEWER: His wheelchair turned over
TRANSLATOR: A little injury
INTERVIEWER: A little injury
TRANSLATOR: When he use the wheelchair he gets tired
INTERVIEWER: He gets tired from using the wheelchair
TRANSLATOR: Her friend drive the wheelchair so fast she have accident
INTERVIEWER: So her friend drives the wheelchair too fast and she has accidents from that
TRANSLATOR: He have pressure sore
INTERVIEWER: Pressure sores
TRANSLATOR: Because the wheelchair
INTERVIEWER: Ok
TRANSLATOR: They have many students that have pressure sore
INTERVIEWER: Many students have pressure sores. #14. What do they think is the best part of the wheelchair? The best feature?
TRANSLATOR: Lightweight best size suitable for him
INTERVIEWER: Smaller and lightweight, suitable for him
TRANSLATOR: She would like to change the caster
INTERVIEWER: The caster
TRANSLATOR: Because this is domestic caster
(Laughing)
TRANSLATOR: She said the motorized so comfortable
INTERVIEWER: The motorized is more comfortable.
TRANSLATOR: The motorized more comfortable for she.
INTERVIEWER: Ok it would be more comfortable for her
TRANSLATOR: She want to exercise. He want a motorized wheelchair
INTERVIEWER: A motorized wheelchair
TRANSLATOR: Lightweight
INTERVIEWER: Lightweight
TRANSLATOR: Stronger wheelchair
INTERVIEWER: Stronger and lightweight

TRANSLATOR: Less, no maintenance
INTERVIEWER: If they could one wheelchair, if the could chose between the tricycle and the standard wheelchair which one would they choose?
TRANSLATOR: Wheelchair
INTERVIEWER: Wheelchair
TRANSLATOR: Wheelchair
INTERVIEWER: Wheelchair
TRANSLATOR: tricycle
INTERVIEWER: tricycle
TRANSLATOR: tricycle
INTERVIEWER: tricycle
TRANSLATOR: Wheelchair
INTERVIEWER: Wheelchair
TRANSLATOR: tricycle
INTERVIEWER: tricycle
TRANSLATOR: tricycle
INTERVIEWER: tricycle
TRANSLATOR: Wheelchair
INTERVIEWER: Wheelchair
TRANSLATOR: Because he love the tricycle because he never use it
INTERVIEWER: Oh he loves the tricycle wheelchair because he has never used it before
TRANSLATOR: The child use tricycle to go outside
INTERVIEWER: He wants to go outside so he wants a tricycle (Laughing)
TRANSLATOR: The wheelchair can go to the department store and the other cannot
INTERVIEWER: Oh, he likes shopping
(Laughing)
INTERVIEWER: Which one would they use more, the tricycle or the...If they had the tricycle and the wheelchair which one would they use more?
: Two type?
INTERVIEWER: Yes if they had two types which one would they use more the tricycle or the wheelchair?
TRANSLATOR: Wheelchair, tricycle use more power
INTERVIEWER: The tricycle uses more power than a regular wheelchair
TRANSLATOR: Wheelchair
INTERVIEWER: If they could change anything in the wheelchair what would they change?
TRANSLATOR: Caster
INTERVIEWER: The casters
TRANSLATOR: He would like to change the tire because when the tire is used for a long time, when the tire must be fixed they have no wheelchair for use.
INTERVIEWER: He would like to change to change the tire because when the tire needs to be fixed they can't use the wheelchair. What else would they change?
TRANSLATOR: The arm supports and seat, new wheel and arm support.
TRANSLATOR: The rail, hand support and seat, brake system
INTERVIEWER: Brake system
TRANSLATOR: He need new adjustment
INTERVIEWER: Anything else that they would like to change in the wheelchair.
TRANSLATOR: The bearing is hard to find

INTERVIEWER: The bearing is hard to find, and maintenance. Is there anything else that they want to ask or say?
TRANSLATOR: He want a motorized
INTERVIEWER: He wants a motorized chair
TRANSLATOR: he want a brake like a bicycle. When he ride wheelchair so fast he want to safety brake.
INTERVIEWER: So safety brake like a bicycle for when he rides the chair fast.
TRANSLATOR: Spare parts hard to find in Thailand
INTERVIEWER: Spare parts are hard to find in Thailand. Can you ask them if they would have any problems using an adult wheelchair?
TRANSLATOR: adult wheelchair?
INTERVIEWER: Yes would they have any problems using it?
TRANSLATOR: It's hard to drive
INTERVIEWER: It's hard to drive, why is it hard to drive.
TRANSLATOR: Heavy weight
INTERVIEWER: It's heavy
TRANSLATOR: The size is not
INTERVIEWER: It's too big; oh he has no hand rim
TRANSLATOR: all wheelchair donate
INTERVIEWER: All wheelchairs are donated
TRANSLATOR: Brake and handrail broken
INTERVIEWER: His brake and handrail is broken
TRANSLATOR: All children are teach how to use the wheelchair, how to maintain
INTERVIEWER: so they are all taught how to use and maintain the wheelchair. Well those are all the questions unless they have anything else.
TRANSLATOR: Normal children use the wheelchair like a toy
INTERVIEWER: Oh they use the wheelchair like a toy, ok. Anything else?
TRANSLATOR: He back is so bigger everyday she has to change the wheelchair for her back.
INTERVIEWER: For her back? So she grows everyday and she has to change wheelchairs.
TRANSLATOR: Yes for suitable, she love this wheelchair because this wheelchair is comfortable for her when she sitting in the class room the level is lower, he need a cushion to increase level.
INTERVIEWER: Oh so he needs a cushion
TRANSLATOR: High level seat
INTERVIEWER: High level seat, and a bigger seat.
TRANSLATOR: Special wheelchair, when she use wheelchair she can't write on the desk.

Resources to Improve the Efficiency and Effectiveness of ThaiWheel Wheelchairs

Resource Package

For use by:

The ThaiWheel Factory

WORCESTER POLYTECHNIC INSTITUTE
Kevin Cornwell
James Dower
Sanford Freedman
Alexandra Vargas

RESOURCE PACKAGE TABLE OF CONTENTS

Executive Summary:

The demand for wheelchairs far outweighs the supply, particularly in third world countries, like Thailand, where regulations and support for people with disabilities (PWDs) are limited. In response, programs are available world wide to help the disabled who need wheelchairs. In an attempt to help the disabled, ThaiWheel, a non-profit organization (NPO), was established in 1999. The factory was launched by a PWD, employs PWDs, and produces low cost wheelchairs. One such wheelchair is a three-wheel design inherent to Thailand and is geared towards functionality in a rural setting. Often the chairs are bought by foundations, like the International Support Group, which have collected money from donations and sponsors, in turn giving the wheelchairs to people who need them the most.

As a NPO, ThaiWheel's goal was to assemble wheelchairs at the lowest cost possible with optimal designs that meet production capabilities and client desires. The factory does not currently know the total cost of producing each wheelchair, but a few imported parts are very expensive and drastically increase the overall price. Also, ThaiWheel does not have sufficient time to research the needs of the market to insure the wheelchairs are meeting the needs of the disabled. If the cost of the wheelchair were known, if options were available to decrease the cost of these expensive parts, and if the consumers who receive the donated wheelchairs were more satisfied, the ThaiWheel organization could produce an appropriate and affordable wheelchair in an accountable and economical fashion.

In order to accomplish the goal of developing a resource packet, several steps were undertaken as methods. The first step required the team to determine the needs of two organizations, ThaiWheel and the International Support Group, and create a project goal that encompassed both groups' desires. The second step involved conducting and analyzing three focus groups to determine customer needs for the

tricycle wheelchair produced by the ThaiWheel factory. The three groups consisted of older Thais, manufacturers of wheelchairs, and young wheelchair users. To complete the third step of obtaining resources to give the ThaiWheel organization, contacts were made at multiple government ministries and with different part manufacturers in Thailand. The final step included the creation, testing, and analysis of a program that the ThaiWheel factory could use to calculate the cost of each wheelchair and evaluate options for making parts or buying them from various locations.

After conducting the methodology, many findings were obtained that would lead to recommendations to improve the efficiency and the effectiveness of ThaiWheel wheelchairs. The findings fell into two major categories of needs assessments and the resource package. The finding for the needs assessments came from the focus groups and through informal interviews with the factory managers. The other results came from the development and analysis of the program and information obtained to place into the resource package.

The findings from the needs assessments related to both the needs of the users of the wheelchairs and the ThaiWheel organization. The users of the tricycle wheelchair and the manufacturers described general use of the tricycle wheelchair to be for outdoor distance travel but not for children. We also learned that general problems with the tricycle wheelchair include difficulty with entry and exit due to wheelchair rolling, difficulty starting the pumping action for propulsion, and difficulty finding spare parts for repair and replacement. Other findings were that disabled children spend most of their time inside and if given the choice would choose a standard child wheelchair over a tricycle wheelchair. Relating to the ThaiWheel organization, we found through informal interviews that total cost for each wheelchair

is currently unknown and that certain parts can be found in Thailand of the same quality, but require large lot sizes and therefore high initial investments.

Findings relating to the resource package included business contacts, a functioning program to conduct Make or Buy Analyses (MBA) as well as calculate total cost, and examples for use of the program and package as a whole. Multiple leads were followed to investigate the opportunities available for the ThaiWheel factory resulting in a list of government ministries and possible part manufacturers. The program developed was analyzed for functionality and ease of use. After the primary user tested the program, both he and the group were satisfied with the results. Further analysis of the program was conducted with a specific example using brakes currently bought by the ThaiWheel organization showing substantial monetary savings. The resource package also includes the discussion of many possible future options including a group buying plan and manufacturing parts currently bought at very high costs.

Conclusions drawn from the results and analyses led to the development of six recommendations to the ThaiWheel factory. The recommendations attempt to improve the efficiency of the ThaiWheel organization by giving them a better understanding of opportunities available for wheelchair cost reduction and a more accurate picture of the cost for each chair. Recommendations for improvements in the wheelchair design allow for enhancement in the effectiveness of the wheelchairs for the consumer.

The first two conclusions were drawn from all three focus groups, regarding the use of the tricycle wheelchair by the old and young Thais with disabilities. Neither the old nor the young spend a significant amount of time in transit, and spend most of their time indoors. Tricycle wheelchairs were not designed for use indoors or

by the young or the elderly. Also, design alterations to make the three-wheeled chair suitable are not feasible. Therefore, we recommend that for future buying strategies, standard adult or child wheelchairs should be purchased to donate to elderly and young people with disabilities, respectively.

The next conclusion was developed from the tricycle wheelchair users. The most common problems with the design included difficulty upon entry and exit, difficulty finding spare parts for repair and replacement, and difficulty starting the pumping action for propulsion of the tricycle wheelchair. Suggestions for future designs included adding reflectors to help with safety at night and adding a parking brake. Therefore, to improve the quality of the tricycle wheelchair produced by ThaiWheel, we recommend that parking brakes and reflectors be added, and to make some spare parts available for retail sale to replace broken ones.

The next recommendation is that the ThaiWheel factory enters the information for all their wheelchair parts into the Economic Analysis and Total Cost Program, regularly update the information, and calculate the total cost of each wheelchair. In this manner, the future comparisons of parts and their effect on the overall cost can readily be determined. The information, however, is subject to change, and it is therefore extremely important for accuracy to update each piece of information on a recurring basis.

The final two conclusions and recommendations are based on use and results of the Economic Analysis and Total Cost Program. From the example input into the program, we recommend that ThaiWheel find the funds to make the initial investment to purchase the domestically supplied brakes to save up to 37% per year on brakes alone. The other recommendation relating to the program is that ThaiWheel use the Economic Option and Total Cost Program to demonstrate to other wheelchair

manufacturers the opportunities and savings that are possible from a group buying scenario. These two recommendations are both good examples of how to use the resource package, but not the only options feasible or available.

In the goal of the project, the desire was stated to create resources to improve the efficiency and the effectiveness of the ThaiWheel wheelchairs. Through the information in the resource packet, both areas were evaluated. Efficiency relies heavily on cost, and through with future use of the Economic Analysis and Total Cost Program, the cost of the currently produced wheelchairs can be reduced. Effectiveness relates to the functionality of the final product for the user. The result of speaking with current users and manufacturers of wheelchairs led to recommendations for future designs changes and donation strategies to give disabled users a better product. Overall, through cost reduction and improved functionality, it is our hope that the lives of many disabled individuals will be improved.

1. Network of Contacts:

    a. Ministry of Industry (MOI)

        i. Contact person, Krisada Israngkul Na Ayudhya

        ii. Telephone number, 644-9421

    b. Board of Investment (BOI)

        i. Contact person, Any (depends on venture)

        ii. Telephone number, 537-8111 or 537-8155

    c. Ministry of Commerce (MOC)

        i. Contact person, Khun Chaiwat

        ii. Telephone number, 225-8411 or 511-5066

    d. List of business contacts, see next page.

Classification : Foundries-Brass, Bronze, Aluminum, Magnesium Etc	
Grasuoy Phengprida (Chitpratima Fctry)	Telephone number
234 Prannok	4122554-5

Chongcharoen Shop	Telephone number
75/57 Daokanong-Chomthong	4681905

Chew Kee Shop	Telephone number
92/1 Charumuang	2142975

Cheng Nam Heng LP Ofc	Telephone number
237/2 Songwad	2224746

Chor Thailand Lohakij	Telephone number
294 Fctry Suksawad	4<img src='/images/nu

Classification : Aluminum Fabricators	
Kiang Sae Chua Ofc	Telephone number
59/11 Phetkasem	4130281

Soy Sae Jia Ofc	Telephone number
422 Suksawad	4277387

S C T Industries Co Ltd	Telephone number
116/38 Theparak	7066266

B F E T Co Ltd	Telephone number
63/43 Phetkasem	8121627-8

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Classification : Aluminum Products	
Kongchai Alumn LP	Telephone number
152/24-9 Nakornkhuenkhan	4630916 4630919

Kong Ouck Sae Yiang Ofc	Telephone number
181/16 New Rd	2890306

Seng Heng Alumn Pan Fctry	Telephone number
98/47 Sukhaphibal 1	4133667 4674100

Kee Soon Huad Shop	Telephone number
235/4 Songwad 1	2215706 2235044

Jib Hong Lohakit LP	Telephone number
12/5-6 Phetkasem	8047251-2

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Classification : Aluminum Products	
Charoenkit Fctry	Telephone number
957/1 Phetkasem	4572212

Charoen Aluminium	Telephone number
3857/7 Phetkasem	4133913

Chue Chin Hua LP	Telephone number
(Facsimile)	2247535
236-40 Yawaraj	2247536-42 2247544-8
236-40 Yawaraj	2247551-3 6227950 6227952-66
236-40 Yawaraj	2211195
1150 Fctry 1 Rama IV	2490271-2 2496920-1 2496924-5
1150 Fctry 1 Rama IV	2247740-3
6 Fctry 3 Suksawad	4625116 4633944-5 8188001-8
6 Fctry 3 Suksawad	8188010
39/67 Suksawad	8188020-3

Chai Charoen Dhawon LP	Telephone number
930 Songwad	2237463-4 2249342-3
102 Yaowapanich	2249344

Sanki Metal Furn Co Ltd	Telephone number
942/6-7 Rama IV	2342363

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Classification : Aluminum Products	
St Louis Alumn	Telephone number
308 South Sathorn	2110597

Narong Kamchang Fctry	Telephone number
15/42 Bangkhunthian	4152895

T Paisarn Indstry LP	Telephone number
48/5 Phetkasem	4132688

Thai Rung Rueng Lohaphan LP	Telephone number
6/24 Patanakarn	4131957

Thai Hua Hong LP	Telephone number
26/10 New Chan	2862803 2862300

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Classification : Aluminum Products	
Nares Alumn Shop	Telephone number
298/140-1 Lukluang	2824217

Bunpakit Industrial Co Ltd	Telephone number
548 Vanich 1	2223546 2228783 2248459
31 Fctry Poochaosamingprai	3942918 3942949 7543453-4
31 Fctry Poochaosamingprai	7559077-8

Peng Kee Shop	Telephone number
529 Bamrungmuang	2236041

Forum Co Ltd	Telephone number
3212/9 New Phetburi	3181773

Yingyong Patana Panich Co Ltd	Telephone number
869 Songward	2223390 2212560 2222434
869 Songward	2214750 2226157-8

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Classification : Aluminum Products	
Bangpakok Fctry (Seal Brand) LP	Telephone number
294 Suksawad 34	4271320 4275388 4270744

Lim Mong Heng Fctry	Telephone number
58 Suksawad	4625270 4627495
(Facsimile)	4634183
231-5 Ofc Chalermkhet 2	2226916 2227454 2244106
231-5 Ofc Chalermkhet 2	2246979
(Facsimile)	2258207

Rienchai Aluminium (1989) Co Ltd	Telephone number
46/1 Phetkasem 91	4310708-9 8111226 8111428
46/1 Phetkasem 91	8111423
(Facsimile)	4310710

Siam Ratana Phant (Chlanuparp)	Telephone number
170/5 Chakrwad	2221720 2216275

U Kosin Aluminum LP	Telephone number
131/2-5 Phetkasem	4675743

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Classification : Stainless Steel-Products	
Hua Yong Lohakarn Co Ltd	Telephone number
848 Theparuk	7530315-9

S T L Metal Co Ltd	Telephone number
18/3 Sukhaphibal	8110961-3

N S Implement Co Ltd	Telephone number
80/103 Ekachai	8978242 8978419

Sahaviriyakit Co Ltd	Telephone number
18/5 Srinakarin	3834063

V P Rangsee Industry Co Ltd	Telephone number
110 Theparak	7080133-52

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แสดงผล หน้าที่ 1 จากจำนวนทั้งหมด 14 หน้า

ชื่อโรงงาน / ทะเบียนโรงงาน	สถานที่ตั้ง / โทรศัพท์	ประกอบกิจการ
MAX AUTO EXPRESS สาขา บางโพ 3-095(01)-159/42 ประเภทโรงงานหลัก 09501	185/1 ม.0 ซ.- ถ.ประชาราษฎร์สาย 2 ต.บางซื่อ อ.บางซื่อ จ.กรุงเทพมหานคร โทร. 912-638	ซ่อมรถยนต์ เช่น เปลี่ยนยาง ถ่วงล้อ เปลี่ยน-ชาร์จแบตเตอรี่ เปลี่ยนถ่ายน้ำมันเครื่อง เปลี่ยนผ้าเบรค เครื่องจักร 13.29 HP เงินทุน 7,000,000 บาท คนงาน 6 คน
กวงยั้งเส็งเบรคท่อไอเสีย 3-077(02)-006/41 ประเภทโรงงานหลัก 07702	1/68-71 ม.21 ถ.รามอินทรา ต.มีนบุรี อ.มีนบุรี จ.กรุงเทพมหานคร โทร. 5173932	ซ่อมแซมท่อไอเสีย เบรค ช่วงล่างและตั้งศูนย์ ถ่วงล้อรถยนต์ เครื่องจักร 70.71 HP เงินทุน 3,920,000 บาท คนงาน 8 คน
กษิดิศ 3-077(02)-002/37สค ประเภทโรงงานหลัก 07702	1/16 ม.7 ซ.ลินประสงค์ ถ.เพชรเกษม ต.อ้อมน้อย อ.กระทุ่มแบน จ.สมุทรสาคร	ผลิตผ้าเบรค เครื่องจักร 47.25 HP เงินทุน 4,470,000 บาท คนงาน 11 คน
การปิโตรเลียม แห่งประเทศไทย 3-091(00)-001/34 ประเภทโรงงานหลัก 09100	2 ถ.อาจณรงค์ ต.พระโขนง อ.คลองเตย จ.กรุงเทพมหานคร โทร. 2490021	บรรจุผลิตภัณฑ์น้ำมันหล่อลื่น และน้ำมันเบรค เครื่องจักร 403.80 HP เงินทุน 160,000,000 บาท คนงาน 42 คน
กิจเจริญการช่าง 3-077(02)-031/23 ประเภทโรงงานหลัก 07702	217-219 ถ.วิภาวดีรังสิต ต.สามเสนใน อ.พญาไท จ.กรุงเทพมหานคร	ทำท่อไอเสียรถยนต์ และอัดผ้าเบรครถยนต์ เครื่องจักร 35.42 HP เงินทุน 970,000 บาท คนงาน 3 คน

Scenario

Actual data from the ThaiWheel Organization was entered into the Economic Analysis Total Cost (EATC) program to illustrate the capabilities of this type of analysis. This program allows the user to enter economic data, makes necessary calculations, and displays important outputs that aid ThaiWheel in difficult decision making situations. There are some qualitative values that are not considered by the MBA that must also be analyzed by the manager.

The program starts by giving the user a place for entering source and economic data specific to each part. In our example the costs associated with buying a brake assembly from two different sources are being compared. Direct and indirect costs for each part were first entered into the buy analysis section of the program (Figure 1).

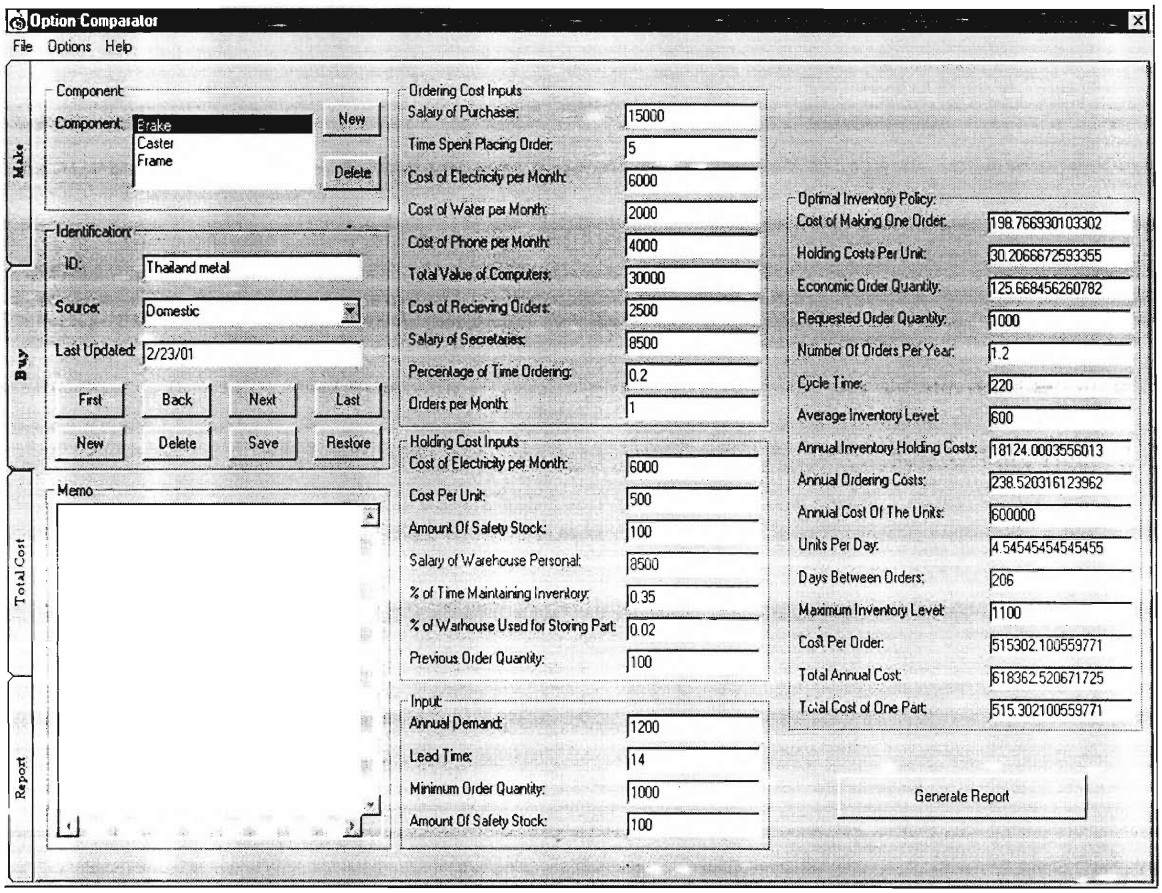

Figure 1: The input page has eight major features within three columns. The first is used to enter source information, the second is for economic inputs, while the third shows outputs calculated by the program.

Column one is made up three subcategories pertaining to ordering and classifying the part. The Component section allows the user to create new part categories and select any of the components previously entered into the program. The Identification area is used to assign unique details about the part and will be displayed on the reports generated by the program. The Memo space can be filled with any useful information that has not been addressed by the report like phone numbers or a contact person.

The second column allows the user to fill in economic data about the part in question. Ordering costs are expenses associated with repeating an order. Some of the

costs related to Reordering are labor (drawing up an order, computer time, supervision), receiving costs, equipment depreciation costs, transportation, and movement costs. The reorder costs can be determined by dividing the total annual costs associated with making the orders by the number of times that the part was ordered that year. Holding costs is the costs of holding an item for a period of one year. These include the indirect costs of capital (opportunity costs), storage space, loss (pilferage), handling, administrative, and insurance costs. These costs are figured by taking the value of the stock and adding the indirect costs then dividing it by the average inventory held over one years time.

Column three contains the Optimum Inventory Policy, which has calculations made by the program to find the lowest overhead for each part. Some of the major factors are Economic Order Quantity (EOQ), the total annual costs of ordering, holding, and total price of part. All of this information can be used to decide if an option is advantageous and/or feasible for ThaiWheel.

EOQ is a mathematical model, which assists the user to minimize the expenses associated with holding stock. It takes into account all of the previous variables reorder cost, holding cost, and unit cost then uses them in a formula to dictate the most efficient order number. Some of the assumptions of the EOQ are that we have a single product, that inventory will never decrease below zero, and that the time that it takes to place and receive that order is defined (lead time). The total annual costs of ordering, holding and price of the parts are calculated and added together to find the total annual cost of carrying this item. From this the total cost of holding one part for one year can be identified.

The program automatically performed calculations after the data was entered and two outputs were produced to show the information in within visual aids (Table 1 and Figure 2). Important comparison factors can be viewed in the spreadsheet and graphical representations of the part.

ID	Source	Total Annual Cost	Total Cost of One Part
Denso	Import	982818.1	819.0151
Thailand metal	Domestic	618254.5	515.2121

Table 1: A screen shot of the spreadsheet, which compares the total annual cost and the total cost of one part from two different companies Denso and Thailand Metal.

The information on Thailand Metal Co. was taken from inputs seen in figure 1, similarly information was gathered on Denso Co. (not shown). Our program derived total annual cost and total cost of one part and has produced a spreadsheet for an easy comparison. Total Annual Cost shows how much it will cost ThaiWheel to buy and store the parts for one year and Total Cost of one part represents the actual amount it will cost ThaiWheel to hold each part. Viewing Table 1, one could deduce that buying the part from Thailand Metal Co. would be more advantageous than buying from Denso Co. in a purely monetary analysis.

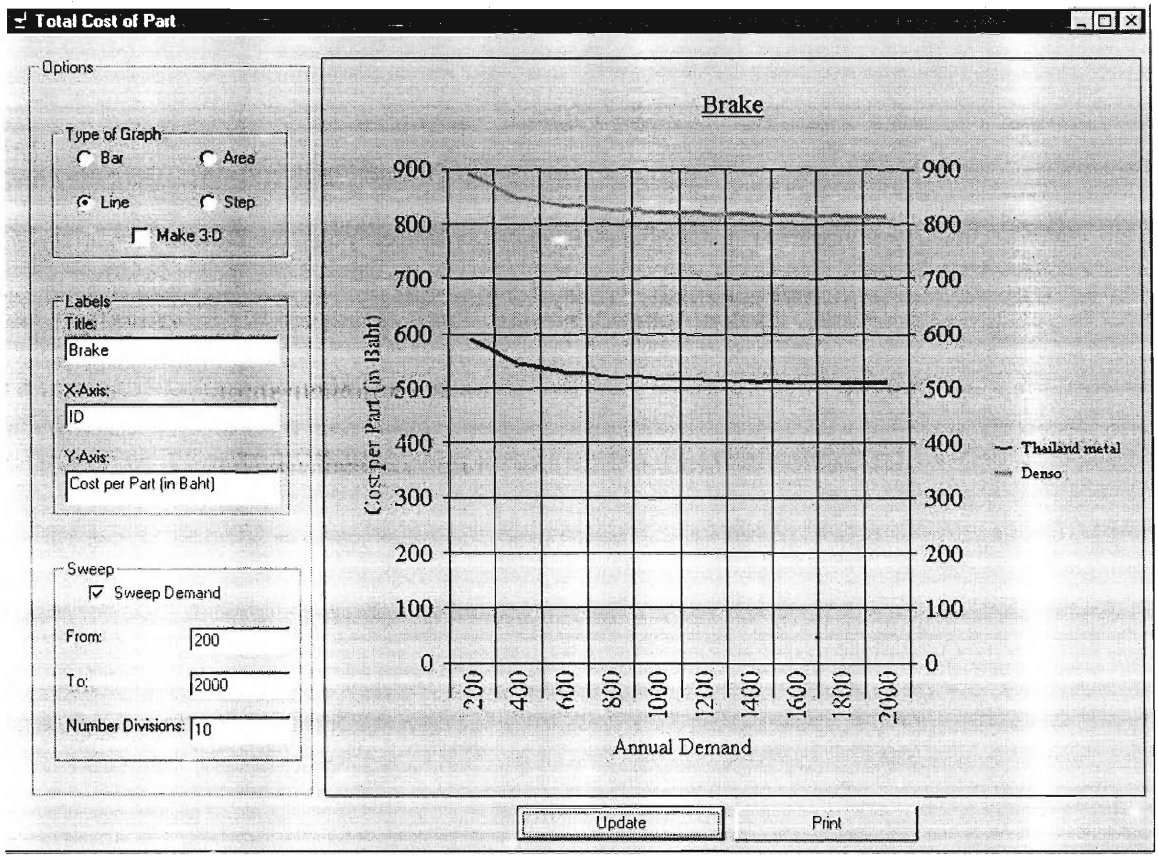

Figure 2: A screen shot of our graphical output shows how the user can choose different types of graphs, pick the part category to be compared, and the sweep of the annual demand. The actual graph shows a total cost per part as per a variable annual demand.

Our graphical representation (Figure 2) displays a variable cost on the vertical axis over a changing demand on the horizontal axis to help show the cost benefits of using larger quantities per year. Since the ordering costs and the holding costs are the same for each option the total cost for each part are independent of quantity. Further more, from observing the graph it can be seen that the total cost of the parts does not drop off much after the demand reaches 900, this would indicate that as long as the demand stays over that amount savings are limited. In ThaiWheel's case they currently require 1200 brake assemblies each year and the graph reflects that amount.

Results from the MBA performed by the EATC program are valid aids in deciding whether or not to pursue a new supplier or not, but they are not the only factors that play into that conclusion. As shown by the visual aids, the costs of the domestic supplier's parts are much cheaper. Not figured into the Make or Buy analysis's are qualitative values like quality and the reliability of the company. Similarly another factor not included is required order quantity. In this scenario the domestic company requires that ThaiWheel purchase at least 1000 units. That would last ThaiWheel for ten months and the initial investment would be B500,000 but a return on investment of 37% is very appealing for any company. Keep in mind that this is a prediction of the total costs to ThaiWheel, the information is based on data from previous years and current prices.

Three Future Options

To demonstrate and further explain the utility of the Resource Package, we analyze three paths ThaiWheel could follow. In the first path, ThaiWheel chooses to keep their current dealer or switches to a new supplier. The second option could be to produce the part for themselves and maybe even produce a surplus of the parts to sell to other wheelchair producing companies and wheelchair part distributors. A third path for Thai wheel to follow includes the option of becoming a wheelchair part distributor either from producing a surplus of parts or from buying a surplus of parts and selling them to other interested parties

ThaiWheel's first option includes whether to keep their old supplier or to find a new foreign or domestic supplier. Assistance in finding new options to buy parts from can be found through the MOI. ThaiWheel can view these options on their website, www.oie.go.th, or through the contact person at the ministry itself. Once found, the new producer could be asked to offer information necessary to update the EATC program and find the total cost of the part. Vital information may include the minimum lot sizes required, the lead time, and the per part cost, all of which can be entered into the EATC program. The calculated outputs seen in table 1 and figure 2 can be observed to decide which option is the least expensive. Undetermined qualitative variables will play a role in the final decision, however. Does the new supplier have the same quality of part? Will they meet the deadlines necessary for ThaiWheel? Does the order quantity exceed

the amount ThaiWheel is willing to buy? A reliable decision can now be made as to what direction ThaiWheel and its suppliers will take.

The next scenario gives ThaiWheel the ability to evaluate the costs and benefits of manufacturing the part themselves. This includes making enough parts to supply their own company and making a surplus of those parts in order to sell them to other consumers. Investigating this option requires using the government agencies and the program from the Resource Package. MOI could be contacted in order to find companies willing to supply the raw materials or subassemblies needed to make the part. Furthermore MOI and MOC could assist ThaiWheel in finding companies willing to buy any surplus parts produced. In order to produce a part ThaiWheel may have to expand their facility and/or buy expensive machinery. If the initial investment were too large for ThaiWheel to handle, then seeking a low interest loan from BOI would be a feasible option. After concluding that producing the part is a possibility, the data can be entered into the EATC program. The output would be compared to previous total cost of the part to find the difference between the two options as seen in table 1 and figure 2. Choosing to produce a part is a complicated decision with relatively large consequences if the venture fails, but the up side is also equally rewarding.

Finally, ThaiWheel has the opportunity to increase lot sizes by ordering parts in a consortium with other wheelchair manufacturers. Due to economies of scale, when order quantities are increased the price of the item usually drops. Investigation into the any cost savings is indispensable since other companies will need to be convinced that participation in such a venture is in their best interest. This alternative also uses many of the resources available in the resource package. BOI can be used to assist in investing in

a larger storage area or any other expansion needs. MOI and MOC could be contacted to find purchasers in Thailand as well as abroad. The EATC program is capable of assessing an accurate cost of the part beyond just the price of the item. The spreadsheet and graphical outputs of the program, as seen in table 1 and figure 2, could be used to confirm the savings associated with purchasing higher quantities as well as to show other companies what they could save. Keep in mind that the actual price of the part may be affected by an increased order size so a new analysis would have to be formulated reflecting the change in price. A benefit of becoming a distributor would be that ThaiWheel could sell parts to the public, something that they aren't able to participate in at this time. A deterrent of cooperating in this manner is the fact that these companies are in direct competition with each other.

Recommendations:

Findings from analysis of the program, are that calculating the cost of making parts and buying parts, as well as estimating the summation of all these parts into the total cost of the wheelchair is a complex and difficult task. The managers at the ThaiWheel factory want to, and need to, know these figures, but have limited time to spend in this manner. Therefore, we recommend that the ThaiWheel factory enter the information for all their wheelchair parts into the Economic and Total Cost Program, regularly update the information, and calculate the total cost of each wheelchair. Four examples of have been input using current data acquired from the ThaiWheel organization, but are subject to change and should be regularly updated. Once all the parts have been input, future comparisons and options can be easily evaluated and their resultant effect on final cost can be seen.

Currently, the ThaiWheel factory imports brakes from Japan at high cost, but a cheaper part of equal quality is produced in Thailand. The domestic part though, a brake, has a minimum order quantity of 1000 pieces, which enough to last almost a year of production for the factory and would require the huge initial investment of over 500,000 baht. We recommend, however, that ThaiWheel find the funds to make the initial investment on the domestic brakes to save up to 37% per year on brakes alone. The savings amounts to over 350,000 baht per year, which could be funneled back into the factory, perhaps towards the in house production of another part.

The ThaiWheel factory has expressed interest in getting wheelchair manufacturers to take part in a group buying venture. To help aid in the development of the venture, we

recommend that ThaiWheel use the Economic and Total Cost Program to demonstrate to other wheelchair manufacturers the opportunities and savings that are possible. Visual aids that stress the monetary savings that could be incurred through the group buying strategy could be present a strong case for other wheelchair manufacturers that may be difficult for them to turn down.

In summary, the goal of the project was to help improve the efficiency and the effectiveness of the ThaiWheel wheelchairs through the creation of a resource package. Efficiency relies heavily on cost. Through future use of the Economic and Total Cost Program, the cost of the currently produced wheelchairs can be reduced and future options can be demonstrated to improve the efficiency. Effectiveness relates to the functionality of the final product for the user. The results of speaking with current users and manufacturers of wheelchairs led to recommendations for future designs changes and donation strategies to give disabled users a better product. Overall, through cost reduction and improved functionality of wheelchairs for the disabled, we hope that the lives of countless disabled individuals will be improved.

Program:

The program is on a compact disk labeled Economic Analysis and Total Cost Program.