Brand Engineering using Kansei Engineering and QFD

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1. Introduction

In product design and development the line between Art and Science is one that is highly blurred. Some academic areas discuss this line, while others do not discuss as it as an issue of importance or disregard the other side as "lacking". In product design, current trends show that the line is a highly visible one. Firms that specialize in product design and development tend to have engineering and art departments, each of which must work together to see the goods from initial concept to realized market product. These departments are key in determining the outputs of the creative process. This division is analogous to a wall that is placed between the two schools of thought, where ideas are thrown over the wall. In throwing the ideas over this wall, they are many times torn apart on the other side then thrown back over. This can create a possessiveness that slows down the development process. Some even enjoy this, and gain a sense of power and prestige when "ripping" apart a design. In analyzing the goals of each of these sides as well as the goals of the customer, this separation should be less predominant. In this paper, a design problem will be approached from both sides of the wall, in which the process incorporates the best characteristics from both areas. This is not to say that other areas of study such as economics and marketing do not play a factor, rather that this paper will concentrate on the relationship between art and engineering and how these two areas can be integrated to create a better product and process.

The term product design and development is loosely used to describe the process by which needs (market, company, or consumer just to name a few) bring about the creation of a tangible item. In many universities design is divided into two different schools, the school of engineering and the school of art. Subjects that relate in engineering are ergonomics, manufacturing, mechanical engineering, electrical engineering and computer science. Many of these studies have "design" classes, however these tend to make up less than half of the classes taken. Within art studies, industrial design concentrates primarily on creating consumer goods, typically three dimensional ones. In the art school, product design also includes packaging design as well as graphic design. Each of these adds something different to product design and development, each possessing it’s own strength's and weaknesses. *Figure 1* is a relatively low detail analysis of the strengths and weakness of engineering and art as compared to some steps of the product design and development process. In theory, it can be thought that combining the best of both of these areas will produce the best results. From the chart we can see that engineering and art have a reversed relationship, where the strengths of one might be the weakness of the other, with some overlaps. For example, engineering excels at minimizing the time to come up with solutions, and the ability to communicate information, while, fun and revolutionary results are not as strong in engineering, but are strong in industrial design.

Study areas / Product design and development	**Engineering**	Organized analysis	Use of measureable units.	Specified methodology	Reproduceable results	Ability to focus attention where needed	Methodological (able to be taugt to others)	**Industrial design (Art)**	Creative	Multiple iterative	Accounts for human factor (personal touch	Greater concentration on user pleasure
Time to come up with ideas		+		+		++	-		-	--		-
Numbe rof iteration roduced		-		+	+	-			++	++	+	
Revolutionary results		+	+	--	-	+			+	+	+	+
Evolutionary results		++	++	+	+	+	+		+	++	+	+
Bring togehther various areas of study		-	+		-	+	+		+		+	+
Produces seccessfull market results		++	++	+	+	+	+		+	+	+	+
Fun		--	-	-					+	+	+	++
Research methds		++	+	+	+	+	+		-	--	--	--
Quick		+		+	+	+			-	--		
Effeciency of work vs. results		++	+	++	+	++	+		-	--		
Communication		+	++	+	+	++	+				+	

Figure 1: Strengths and Weakness of Art and Engineering

2. The project

2.1 Background Information

To take advantage of the strengths and weaknesses of art and engineering, an attempt has been made with an industrial design project at the University of Michigan School of Art and an independent study course in the College of Engineering with Glenn Mazur. Undergraduate students typically take a series of four or five industrial design classes for their degree. The class chosen was Industrial Design II. This class was chosen because of the relative simplicity of the problem posed. The problem posed was stated as:

> You will be designing a Foldable Portable Body Support. The project will be done in student teams of two or three people. This project will explore the simple mechanics and the structural requirements of supporting a person. Designs can take on problems in the residential environment, the recreational environment, or can be cross environmental in purpose. The design solutions must take into account the manufacturing capabilities of the U. of M. shop and the materials that can be fabricated using those capabilities.

The time given for this project was three months. Work was done in groups of three. As the deadline approached and work for groups seemed not to be progressing towards closure for many groups, the deadline was extended by two weeks, for a total project time of three and a half months. It was stated by the industrial design professor that it was "an ambitious schedule and that it will be adjusted if we run into problems as the semester progressed." This is typical for many projects that deal with problems of this sort.

2.2 Identification of general market segments

Our group's first step was to determine possible customer segments within the confines of the problem statement. These segments were theoretical segments that might exist and were broadly stated in comparison to the desires of the group. Three recreational and three residential segments were used. *See figure 2.*

Project: Design of portable foldable chair

Chair design	hospital	home	space	camping	sport	general
Innovative	1	2	3	3	3	2
Safe	3	3	3	3	3	2
Simple	2	1	0	2	2	1
Fun	1	2	1	2	2	2
Compact	3	2	3	3	3	1
Inexpensive	0	2	0	2	1	1
Totals	10	12	10	15	14	9

Definition of Values:

Row Entry	Values
Extremely important	3
Very important	2
Medium important	1
No importance	0

Figure 2: Broad customer segments

This matrix was filled out collectively by the industrial design group. The three segments with the largest scores were the home, camping and sports segments. These segments were further analyzed based on personal experience to include college students who might need to take a quick rest while waiting in line for events, or when needing to temporarily shift the weight off of their feet for some time. Choosing oneself as the target market segment is common among designers, This can be both good and bad. For this project, choosing a segment that was close to ourselves was beneficial. Depending on what is driving the problem as well as other factors, this may or may not be the best choice.

Some initial designs were generated. These initial designs were necessary to "pour out" all of the ideas that initially came to the designer's minds, however narrowing down of the concept did not happen until later in the project.

2.3 Identification of target postures

To further analyze the problem in general, a broad analysis of comfortable postures was created. *See figure 3.* In doing this, limits of the human body were accounted for from the beginning of the design. The word "limit" is used due to the fact that the human body has limitations set by its physical characteristics. Further study can be done on this using ergonomic analysis. This is an example where engineering may benefit the industrial design process. Human factors engineering or ergonomics utilize anthropometric information, which can help early in the design phases. In section 2.19 anthropometric CAD models are used to analyze the feasibility of the stool height.

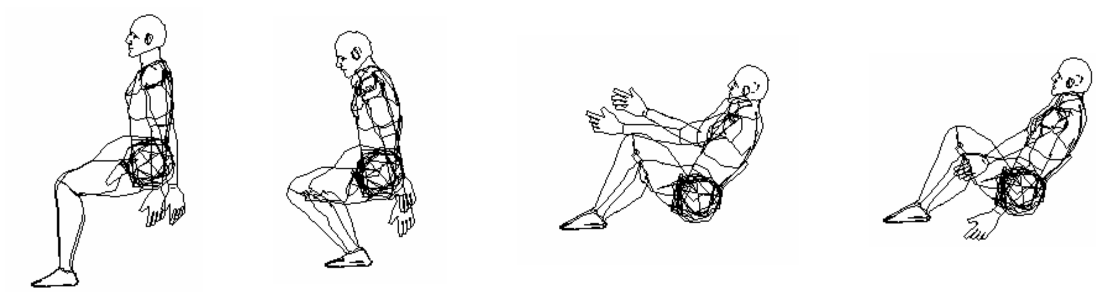

Figure 2: Seating postures

A position that that is similar to sitting in a chair was chosen due to factors that are reflected in information obtained from the house of quality. This will be further discussed in detail in the chapter dealing with the house of quality. One reason why this posture was chosen was because of the small time and effort needed to move from standing to sitting in this position. This position can be considered to be uncomfortable for long periods of time, however the target segment chosen would only use this stool for temporary shifting of their weight and not for prolonged use of more than three hours. This served to further narrow down our target customer segment. This segment research was industrial design oriented. A more comprehensive approach is taken *when "Going to the Gemba"* is discussed in section 2.5

2.4 Kansei engineering

To fully incorporate the needs of the customer a relatively new method to the United States called Kansei design was employed. Kansei is the Japanese word for sense. This brings analysis of the senses to the process. Metaphors are used and the user's experience is scrutinized by the different feelings that are created by the product and the different senses that are touched by it. Kansei design can be an integral part of the process, as seen in *figure 3*.

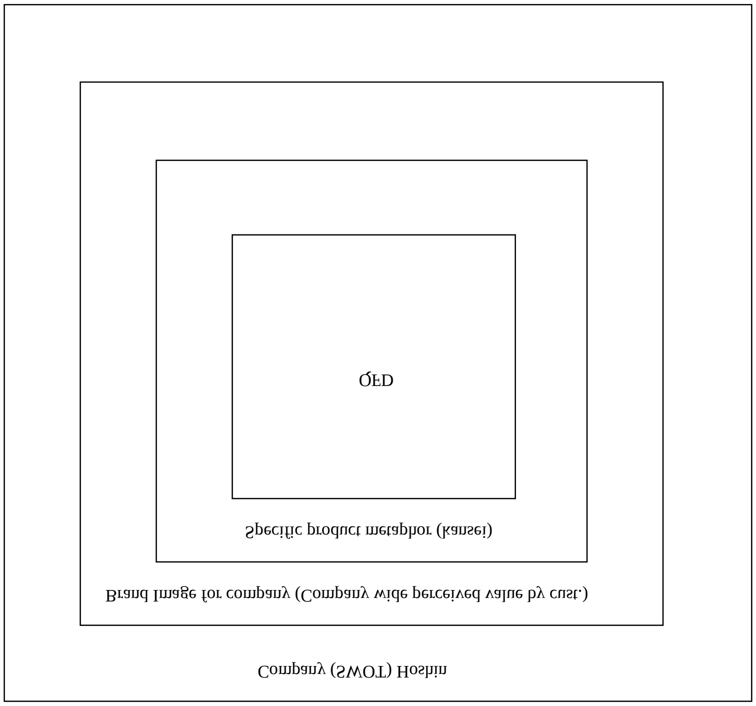

Figure 3 Target of Kansei work

Figure three is one interpretation of how Kansei engineering can be incorporated in to the product design and development. In this diagram the outer ring is the company's strengths and weaknesses (SWOT). This then translates into the next inner cube, which is the company's metaphor or brand image they are trying to portray. The next inner cube is the specific product metaphor that, which is the new product being developed, this must be in agreement with the two shells before it. Fourth is Kansei engineering which takes the product metaphor and translates it into feelings. Finally there is Quality Function Deployment (QFD) which can be considered the target of the product design and development process, where all the details are worked out and must be in agreement with all the other rings. As the cubes get smaller (or rings) the detail relative to the product becomes greater. Not only does the detail get smaller but the metaphor gets more specific as well.

In this paper, the Kansei engineering work was not as fully incorporated into QFD as it could have been. In many places such as the House of Quality, and the fault tree analysis (both of which will be discussed later), Kansei design can be incorporated into the process.

To better understand the trends of the target market a matrix data analysis of theoretical customer trends was done for the chosen customer segment. This plot visually represents the buying trends of the market segment. Members of the customer segment rate certain products on a one to ten scale from inverse pair attributes using the Semantic Differential; for example truncated features to completeness, ten being more complete. They would also be asked to rate on a one to ten scale for the same products as to whether they are small to large in size, ten being closer to large . An abbreviated data matrix analysis of theoretical customer trends is shown in *figure 4***.** A more exhaustive use of this technique is, of course, to be done.

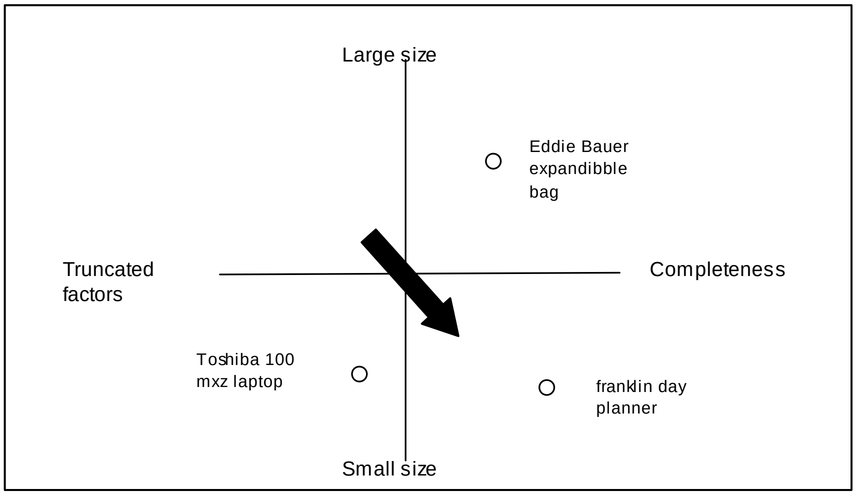

Figure 4: Matrix Data Analysis of Semantic Differential of market segments.

If this example were to have more points of data, we would be able to observe that there is a trend towards smaller sizes and completeness. This further adds to our definition of the target market segment. One of the products used in the semantic differential was then used as a metaphor for our new product. In doing this, the desired traits of the metaphor can be translated to the new product. The shortcomings of the metaphor can then be accounted for as well. A LCD screen was used as a metaphor for the chair, where traits like less mass for same function and supports more per area are traits that would benefit the new product. As seen in *figure 5*.

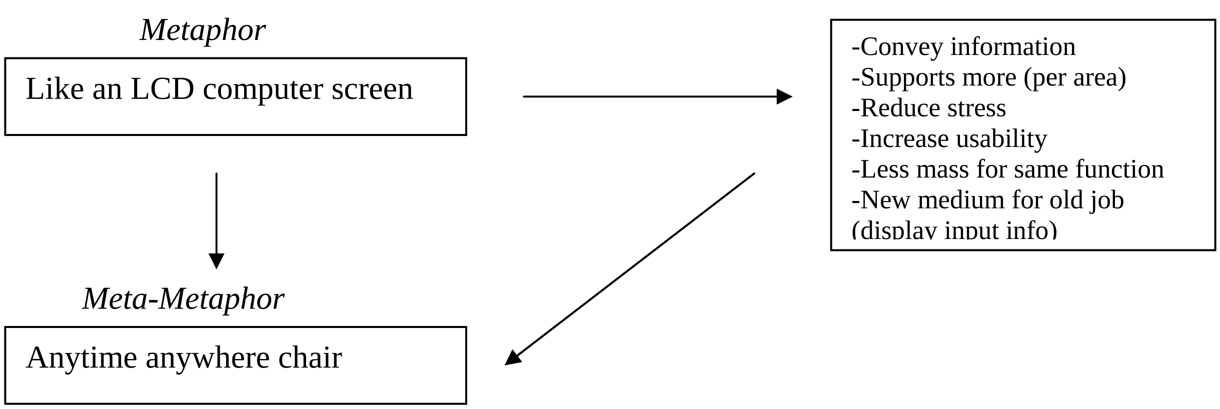

Figure 5: Creation of meta-metaphor

A meta-metaphor was then created from the desired traits. This meta-metaphor is descriptive term for all the traits that were obtained from the metaphor that pertain to the new product. This meta-metaphor can then be used as the head of a fishbone diagram, where the broad ideas in the meta-metaphor can be detailed out. *Figure 6* shows the fishbone diagram and the four main areas that contribute to the metaphor.

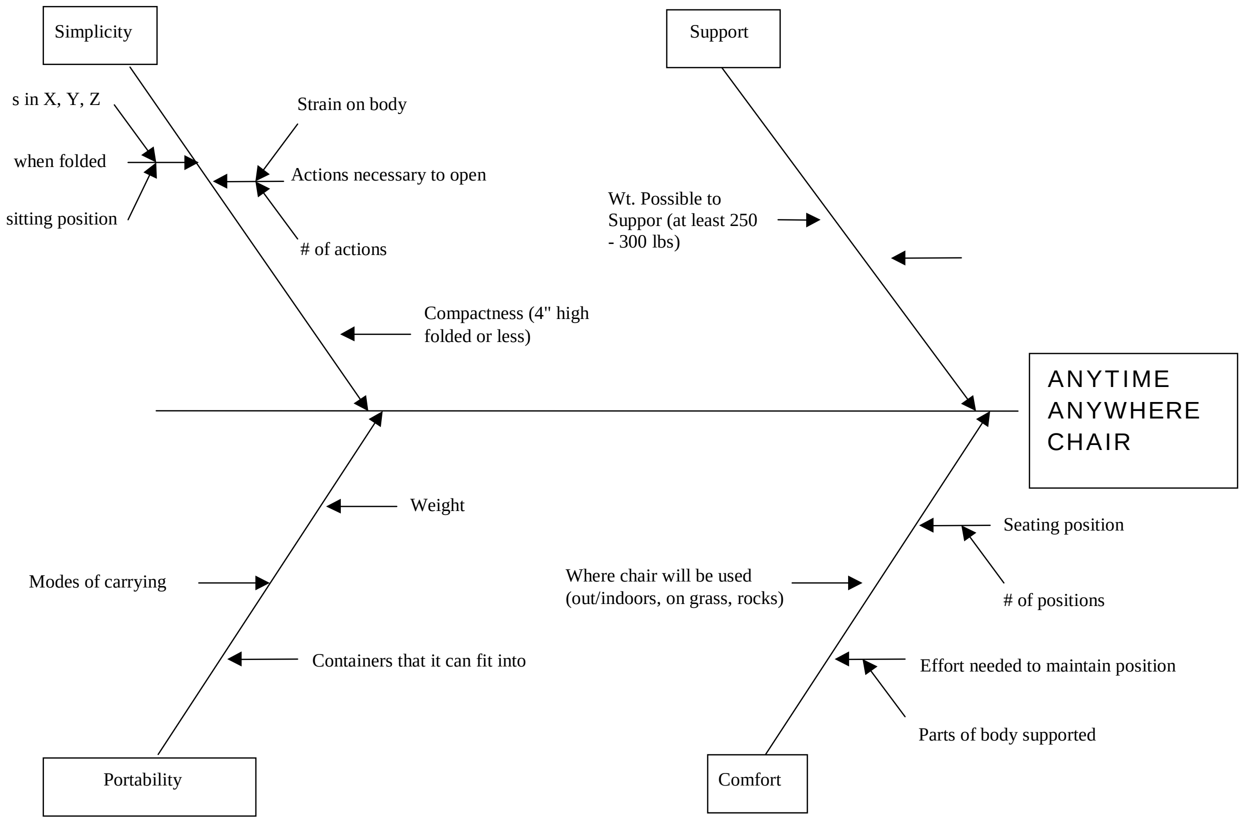

Figure6: Fishbone of Meta-metaphor

These feelings are those of comfort, portability, simplicity, and the feeling of support. This tree diagram can also be arranged as to the level at which the feelings are on. In the fishbone diagram it can be seen that there are different levels of detail upon which the feelings lie. In ***figure7***, we see that zero level is that of the meta-metaphor, the first level contains the major branches and the second level contains the next level of detail from each branch. The levels in *figure 7* are not filled but the information can be taken from the fishbone.

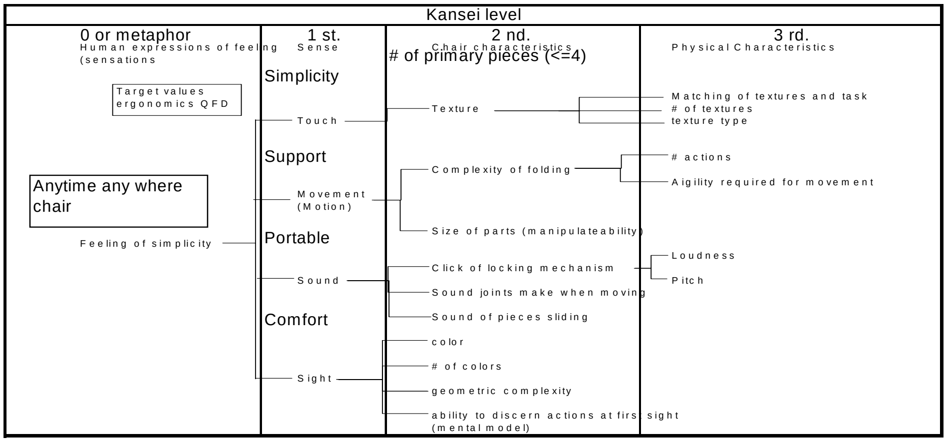

Figure 7: Leveled arrangement of meta-metaphor fishbone diagram

Each of the four senses, touch movement sound and sight are analyzed with respect to the product, in the sense tree. This chart facilitates in determining how each of the senses can be approached to convey the desired feelings. If necessary, attention can be shifted between senses. In creating this chart we can also fill in some information that might have been missed when creating the fishbone diagram of feelings.

2.5 Going to the Gemba

Feelings play a large role in whether a product's designed in functionality is utilized or not. Kansei engineering does not address the functionality but rather concentrates on the perception of it. This perception may be founded or unfounded in qualities present in the product. Possibly one of the worst thing that can happen to a product is that designed in functionality is not reflected in it's perception, and as a result is not utilized. There are many ways in which perception effects function, as well as the function effecting perception. To begin to design the required functionality that is required, a process called "going to the Gemba" was employed. "Going to the Gemba" can be equated to going where the new product will probably be used and observing. When going to these places, questions were asked of the customer segment in the form of who, what, when, where, why as well as how. *Figure 8* shows some of the questions asked in the context of this project.

Customer segment questions: (5W & 1H)

General question

1. Would you use a support device instead of standing when tired

Why

1.Why would you decide to use a chair instead of standing?

Who

1.What is the student studying. What are their hobbies

What

1.What size you would want it to ideally be.
2.What do you use now if you are in the need for a quick rest.
3.What would you use such a chair for (sitting, propping stuff up).**P**

When

1.When would you use it or need it available, All the time, occasionally, available always?

Where

1.Where would you use such a chair (outside, sporting events,) which sporting events?
2.Where you would put the chair when not in use

How

1. How often would you use it.
2. Modes of carrying
3 How would use the support device ideally.

Are there any other suggestions :

Figure 8: Customer segments defined by 5W1H of use

2.6 Voice of customer information

The information gathered was then organized into tables that clarified the voice of the customer (VOCT tables). These tables allowed for information about the wants of the consumer to be directly designed in. The VOCT1 rewords information such that unspoken information about needs can be obtained. *See figure 9*. This information is then further organized in the VOCT2 such that demanded quality items can be obtained from them. *See figure 10*.

1	4	Customer	3 5 Use										
Cus	Voice of the	Character	Who		What		When		Where		Why		
ID	Customer	istics 2	I/E	Data	I/E	Data	I/E	Data	I/E	Data	I/E	Data	I/E
1	Lazy and		E	Engin M	I	Seating	E	All the	E	All	E	Lazy and	E
	wants to sit					for events		time		different		want to	
	down after					I enjoy		(carry)		events		sit down	E
	standing a long	College											
	time	student			I	Sitting on	E	Use once	E	Air shows			
		w/medium				the floor		a week					E
	All different type	amount of				is not			E	In line to			
	of events like	accesiories				enjoyable				get a			
	an airshow,									ticket			
	in line to get				I	Sitting on							
	tickets or any					the ground			E	Packed			
	long line					is not				class			
						comfortable							
	Normally sit												
	on floor												
	Supprort back												
	but and arms												
	would be nice												
	No sharp edges												
	No Stretch												
	in seat												
	Large enough												
	to relax												

Figure 9: VOCT1

Cus ID	Demanded Quality (benefit)	Feature Quality Characteristics	Function	Reliability	Other
1	Rests stable on many surfaces			Stable outdoors/ indoors	
1	Coexist with other objects			Carry all the time	
1	Have functions of a chair at home		Provide comfort		
2	Always available				
2	Elevates person comfortably above ground		Better than sitting on floor		
2	Can be carried conveniently	Light weight			
2	Readily accessible	Low Complexity			
3	My legs are free to move		Reduce standing time		
3	More energy/ time for other activities	Quick Deployment			
3	Easy to open	Deployment energy			
3	Looks sturdy	Joint tightness stability			
3	Comfortable			long life /material does not stretch	
3	Can be used to reach high up shelves				

Figure 10: VOCT2

2.7 Using the house of quality

The demanded quality items were then brought into a House of Quality matrix (HOQ matrix) in which the demanded Quality items were compared to quality characteristics. These quality characteristics are criteria that relate to measurable properties of the product such as "area available for body support" and "volume when closed". These quality characteristics are compared with the less quantifiable demanded qualities such as "readily accessible" and "can be placed on many surfaces." *See figure 11.*

Foldable/ portable chair	Seat portability	Tolerances of joints	Maximum weight supported	Weight of seat	Proportions when closed	Volume when closed	Volume open	# of members	Comfort/ stability	Area of seat touching ground	Height of seat off of ground	Area available for body support	User's actions	Time required to open /close	Force required to open/ close	Hip Bending angle required to open/ close	# of movements required to open/ close	Material properties	# of materials used	Melting point of material	Material elasticity	Importance rating (1)	Current service (2)	Competitor	Plan (3)	Improvement ratio (4) (4)=(3)/(2)	Sales point (5)	Absolute Wt. (6) (6)=(1)X(4)X(5)	Demanded quality Wt. (7) (7)=(6)/Sum(6)x100
Comfortable																													
My legs are free to move		1	3					1		3	3	9									3	2	2	3	3	1.50	1.0	3	6
As comfortable as a chair at home		1					1				3	9									3	3	2	4	3	1.50	1.0	4.5	9
Can be carried conveniently																													
Coexists with other objects carried				9		9	9	3		1										1		4	4	2	4	1.00	1.5	6	12
Readily accessible				3		9		3			1											3	3	1	3	1.00	1.2	3.6	7
It can go Anywhere																													
Keeps person comfortably above ground		1	3				3			9	9	9									3	3	3	3	3	1.00	1.2	3.6	7
Can be placed on many surfaces		1								9												3	3	4	4	1.33	1.0	4	8
Looks sturdy		3	9	3		1	3	3		3	3	3							3			3	2	3	3	1.50	1.2	5.4	10
More energy/ time for other activities																													
Can be used to reach high up shelves		1	9				3			3	9	9		1							9	1	2	1	3	1.50	1.0	1.5	3
Quick to open			1	3		3								9	9	1	3			1		5	2	2	4	2.00	1.2	12	23
Easy to open		3		3		3	3	3			1			9	9	9	9				1	4	3	3	4	1.33	1.5	8	16
Absolute Weight		110	182	273		294	221	140		202	186	251		352	349	163	209		31	35	106								
Quality Attribute Weight		4	6	9		9	7	4		6	6	8		11	11	5	7		1	1	3								
Our Current Performance		1/8	190	3		1/3	3.7	6		1.2	18	1		45	4	90	5		1	1	2								
Competitor		1/16	250	3		1/2	3.6	11		0.4	16	1.4		38	2.5	75	3		2	1	1								
Target		1/8	250	2		1/3	3.7	6		0.8	18	1		33	3	80	5		2	1	2								
Unit of measurment		Inch	Pound	Pound		Cubic Feet	Cubic Feet	#		Square Feet	inches	Square feet		Seconds	Newtons	Degrees	#		#	Degrees celsius	Modulus of elastici								

Figure 11: House of Quality

2.8 Creation of Design #1, and use of fully functioning models

The next step was to design prototypes. These were first done in Matte board as a general shape mockup and then wood was used. *See figure 13.*

Figure 13: Images from initial "mock-up" model

The initial wood mockup of the concept was successful in its goals for that stage of the design. It safely supported a person's weight, as well as fold to the size of large laptop computer. The dimensions for the closed position were taken from the dimensions of the largest binder a student would typically carry, while still being able carry other important items in their bag. In this Design two different types of joints were tested as well. One joint design had two pieces while another joint design had three. From an aesthetic point of view, the design group agreed that the two piece design was simpler and more unique. This design was then decided against due to cracks forming in the two piece joints, upon testing the wood model. The three piece joints were fault free after repeated usage. The stresses created in the two-part joint were greater than those that were generated in the three part joint. A more detailed engineering analysis might serve to give a more accurate assessment of the joints.

2.9 Demanded Quality vs. Function Matrix

A function tree was then made to ensure that all functions necessary for the portable folding stool were accounted for. *This is shown in figure 14.*

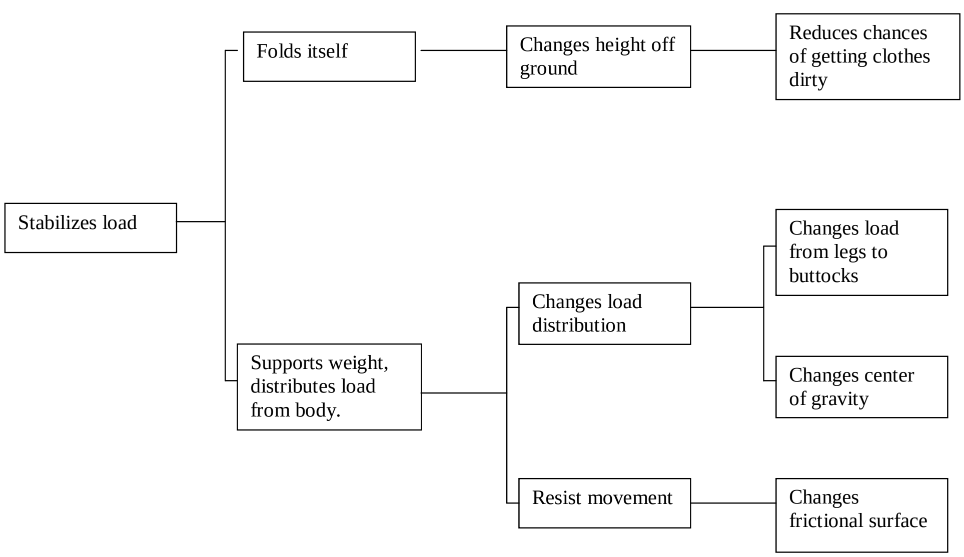

Figure 14: Function tree

The Demanded quality items were then compared with functions from the function tree. This was done to prioritize functions based on demanded quality, assure there is a function for every demanded quality and check the completeness of the function tree. *See figure 15.*

	Stabilizes load	Folds itself	Changes height off of ground	Reduces chances of getting c	Supports weight, distributes load from	Changes load distribution	Changes load from legs to bu	Changes center of gravity	Resist movement	Changes frictional surface	**Demanded Quality weight**
Comfortable											
My legs are free to move				1			9	3		1	6
As comfortable as a chair at home				1			9	9			9
Can be carried conveniently											
Coexists with other objects carried											12
Readily accessible											7
It can go Anywhere											
Keeps person comfortably above ground				9			3	1		3	7
Can be placed on many surfaces				1						9	8
Looks sturdy											10
More energy/ time for other activities											
Can be used to reach high up shelves				1						3	3
Quick to open				3							23
Easy to open											16
Absolute Weight				149			156	106		108	
Function Weight				29			30	20		21	
Rank				2			1	4		3	

Figure 15: Demanded Quality vs. Function Matrix

The same process was done with demanded quality and function and the function matrix. *See figure 16.*

	Stabilizes load	Folds itself	Changes height off of ground	Reduces chances of getting	Supports weight, distributes load from	Changes load distribution	Changes load from legs to bu	Changes center of gravity	Resist movement	Changes frictional surface	Quality Characteristic weight
Seat portability											
Tolerances of joints											4
Maximum weight supported											6
Weight of seat											9
Proportions when closed											
Volume when closed											9
Volume open/ volume closed											7
# of members											4
Comfort/ stability											
Area of seat touching ground											6
Height of seat off of ground											6
Area available for body support											8
User's actions											
Time required to open /close											11
Force required to open/ close											11
Hip Bending angle required to open/ close											5
# of movements required to open/ close											7
Material properties											
# of materials used											1
Melting point of material											1
Material elasticity											3

Figure 16: Quality Characteristics/ Function Matrix

2.11 Theory of constraints, and Undesirable effects (UDE's)

An alternate way of looking at the voice of the customer was to use a tool from a methodology called theory of constraints. The tool used looks for undesirable effects (UDE's) and creates a tree in which the factors that contribute to seventy percent of the undesirable effects are your most important ones. *See figure 17.*

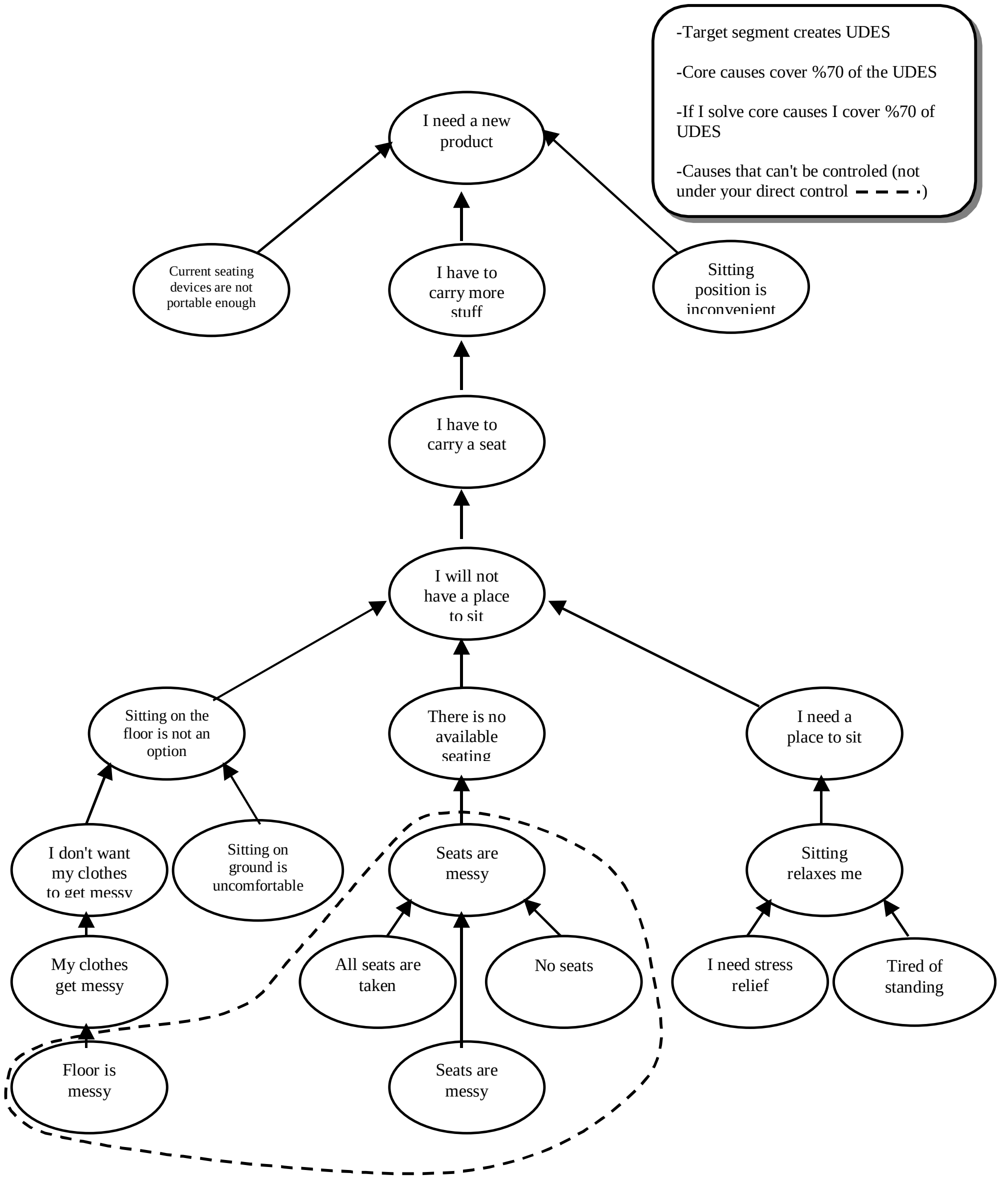

Figure 17: Theory of constraints, Undesirable effects diagram.

In doing this, more information on the needs of the customer as well as failure modes of the product are found. Information that was not obtained in the VOCT tables was filled in by the undesirable effects diagram.

2.12 Fault tree analysis

Possible faults of the product are further analyzed in the fault tree analysis diagram. In this tree possible areas of fault are organized. This is to further insure that information that may not be present in the some of the other matrices is accounted for. ***See figure 18***.

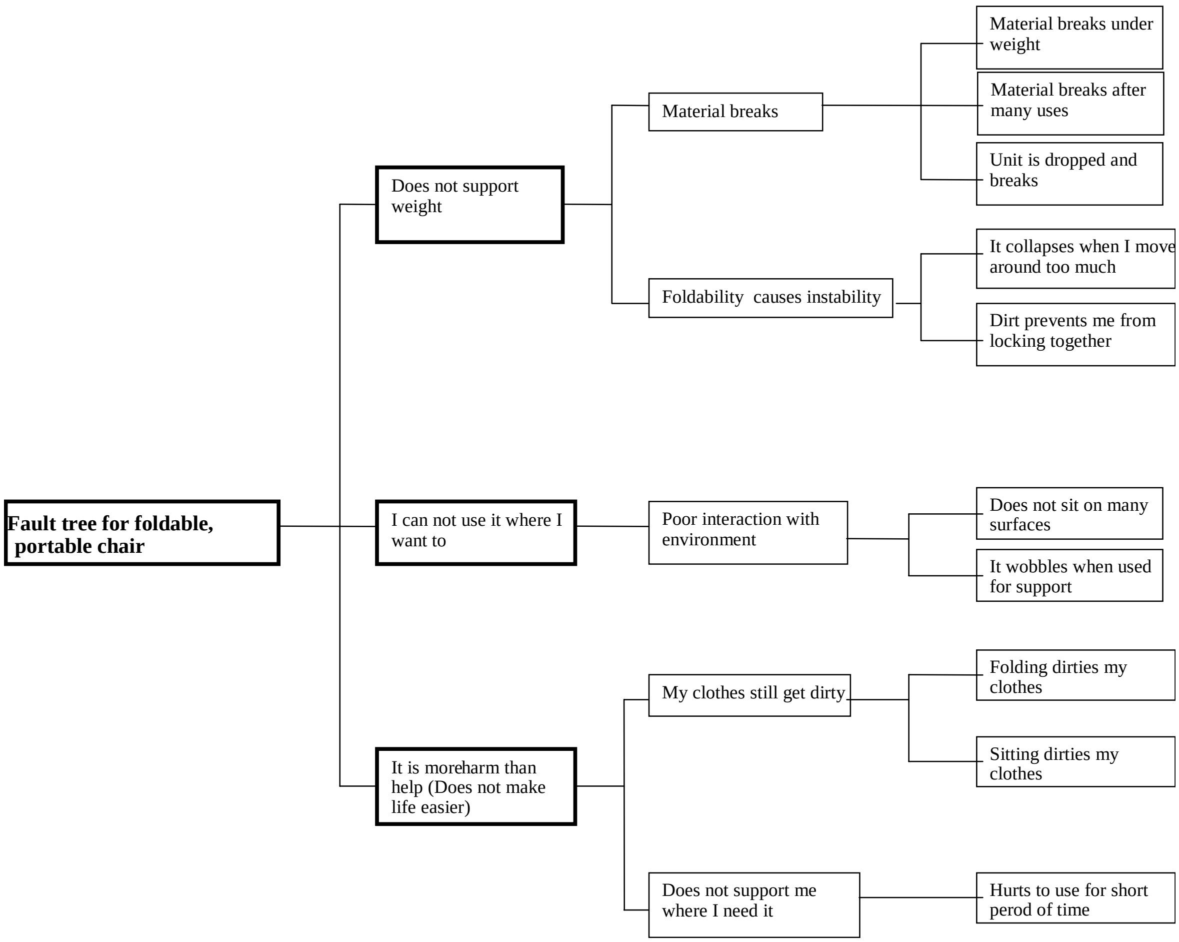

Figure 18: Fault tree analysis

2.13 Analysis of design #1

In the project there were three concept stages. In the first stage ideas were presented in the form of hand drawn sketches. The second stage was one of rough model-making and testing. The third stage was one in which the concept was further detailed out using computer models and a final presentation model was made. ***Figure 19*** shows the three stages and how the design progressed from one stage to another.

Figure 19: Three stages of concept

In the first design stage there were many areas for improvement. A few important issues that were determined were how the chair rests on the ground, How the members slide when opened and how the chair locks together to sit stable. These problems were thought of through group analysis using many designers not directly involved in the project. To verify that these were indeed areas of interest for the design to head towards, these ideas were then looked at using the HOQ. It turned out that these items were of high importance rating in the house of quality. This is because items such as "Can be placed on many surfaces" and "Quick to open" and "Easy to open" scored high in the demanded quality weight, reflecting their importance to the consumer.

2.14 TRIZ

To design the bottom surface a methodology called Triz was then employed. The conflict that Triz was asked to solve was how to have the bottom of the stool rest be able to rest on few points when the surface is rocky with pebbles or uneven surfaces other, and any points when the surface is wet or soft such as grass. These two ideas have conflicting design criteria. The results from the attempt to use the methodology were unsuccessful. Through brainstorming a solution was found. This solution was similar to an idea that Triz had proposed, that of separation in space, but that was not the method by which the answer was obtained.

2.15 Creation of design #2, improvements made

In approaching these problems and attempting to solve them, a second design was created. This design incorporated a modified base, a track system for smooth sliding of members, as well as a modified locking mechanism that was simpler quicker to use and more reliable. *See figure 20.*

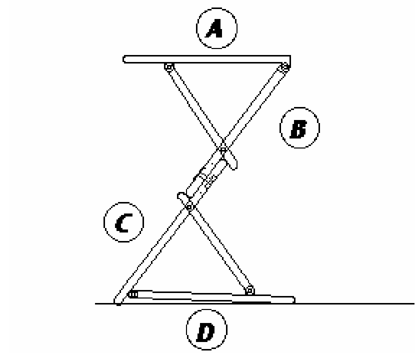

Figure 20: Concept two (side view)

2.16 Design comparison

To compare these two concepts a comparison matrix was created. In this matrix, the two ideas were compared against each other. Comparing these design along with a current market product along the same lines would be better for this matrix. From this matrix it can be seen that the second concept far surpasses that of the first. *See figure 21*.

Foldable/ portable chair		Concept 1:Two mirrored sets of parts	Concept 2:Three parts, changed sliding, base and lock	Demanded quality Wt. (7) (7)=(6)/Sum(6)x100
Comfortable				
My legs are free to move		+	+	6
As comfortable as a chair at home		S	S	9
Can be carried conveniently				
Coexists with other objects carried		+	S	12
Readily accessible		S	+	7
It can go Anywhere				
Keeps person comfortably above ground		S	+	7
Can be placed on many surfaces		-	+	8
Looks sturdy		S	+	10
More energy/ time for other activities				
Can be used to reach high up shelves		S	S	3
Quick to open		S	+	23
Easy to open		S	+	16
Sum of pluses		2	7	
Sum of minuses		1	0	
Weighted plus		18	77	
Weighted minus		8	0	

Figure 21 Concept selection

2.17 Selection of colors

Collectively the design team selected the colors of the product. We designed the product for monochrome and added color as a redundancy as well as for aesthetic pleasure. The main color was to be red. A bright color was wanted to convey the idea that the product is light despite it's somewhat bulky appearance. However the market segment avoids bright colors when given a chance. Red was an in-between color that was felt to be neither too heavy nor light looking. The middle members were colored yellow to signify their importance, make them easier to locate and add some contrast to the design.

2.18 Possible areas for improvement in the design

Some features that could have been designed that were not, Graphics that indicate how to operate open, close, lock and unlock the stool. Graphics might also include personalization such as university logos or interesting artistic pieces. When unfolding the stool it is difficult to determine which side the bottom is, this might be alleviated by removing some of the excess material. In doing this, the bottom might be differentiable from the top and they will not easily be confused. A handle might be a useful item in that it might aid in opening the device as well as aid in carrying it or putting it into bags such as backpacks. A pouch is another possible addition that would reduce the effects of the UDE's. In placing the chair on grass the bottom might become tangled with dirt, a container might serve to protect belongings from the dirt when placing the bag in a backpack, and it might serve to remove the dirt from the stool. A container that does this is being designed by one of the group members for another course in packaging design. Designing a place to hold personal items in chair such as change for the bus might be useful. Having the ability to lock the chair closed when carrying might make carrying easier, this may also be done by the container concept. Having the ability to carry the design by itself might be useful, this might be done by the handle or by the container device.

2.19 Use of anthropometric information

When designing the stool, anthropometric information was used to double check the usability of the design. In design, the seat height was designed to be able to accommodate the largest of individuals. This is characterized by anthropometric data for the 95th percentile male. *See figure 21*.

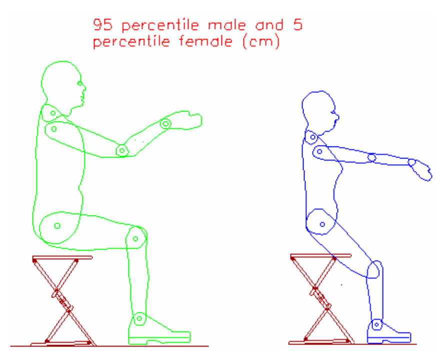

Figure 21: Anthropometric models

2.20 Industrial design presentation

or the Industrial design class presentation boards were made to summarize the stages of the design, *figure 22* is the presentation in the form of overhead transparencies that were used. Along with this a computer model as well as visually realistic model was created.

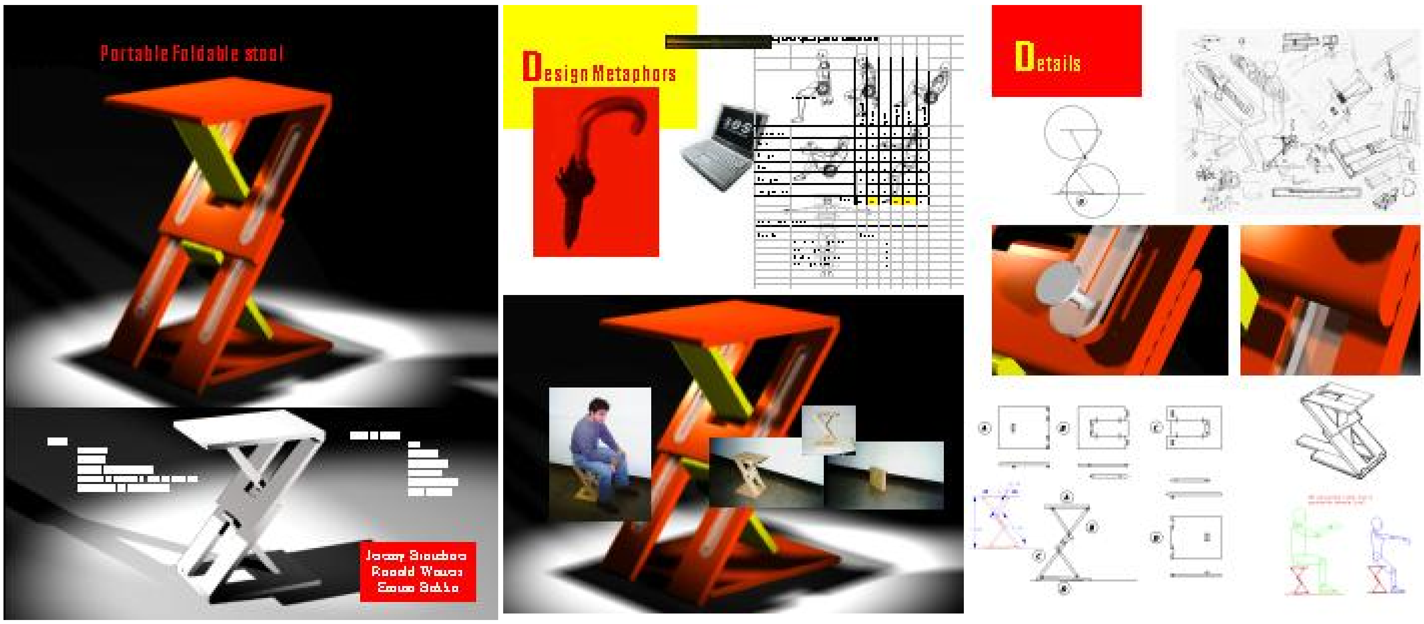

Figure 22: overhead transparencies from Industrial design class

2.21 Manufacturing possibilities

Manufacturing was stated as part of the design problem, however this was not thoroughly accommodated for in the process as it ideally should be. If it part deployment were to be included in the process, a matrix would be made that compares each part of the design to the quality characteristics. In doing this we can see where weakness lie and what may have to be redesigned to accommodate manufacturing. In actual production, the majority of the stool would be made out of plastics such as ABS for the and high density polyethylene for the track guides. The pins would be aluminum. In being plastic, to reduce weight and the chances of warping when cooling, the seat would probably have some type of grid on the sides that would allow them. This was not accommodated for because the facilities of time and people were not accommodated for. In the design process manufacturing should be incorporated into the process from early stages of development.

3. Conclusion

In this project art and engineering were successfully incorporated in to the product design and development process. Combining the different techniques to view the problem from all angles did this. Using Methodologies such as Kansei engineering/ design to obtain information about the senses that normally is only a vague model in the designer's head. Also, When searching for possible problems or areas of improvement in the design QFD analyzes the possible solutions to see whether the feature is important to the consumer and quantifies that importance.

Time was also saved in the process because our initial concept functioned as desired. In the process it was also easier to determine whether an item was of importance or not. Question that were not voices by consumers until presentation in front of a large audience were brought up using the function tree and UDE's diagram. This allowed for an encompassing product to be made that surpasses the users expectations and "wows" them.

References

Mazur, Glenn. 1996. *Comprehensive QFD for Products v 5.0*

Nagamachi, Mitsuo 1993. *Kansei Products.* Kaibundo.