Jurassic QFD

Integrating Service and Product Quality Function Deployment

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Abstract

Quality Function Deployment is a unique system for developing new products which aims to assure that the initial quality of the product or service will satisfy the customer. In today's turbo economy, traditional design methods that rely on extensive concept and market testing and multiple rollouts take too much time and increase risk that copycat products enter the market first. Best efforts driven by internal requirements risk failure to recognize important customer needs. The tools and methods described in this paper will show how these risks can be minimized with proper planning. This paper will also show how QFD can be customized to a specific project, especially to design a tangible product, an animatronic dinosaur, to be used in a service operation (theme park attraction).

Key words

Animatronics, industrial design, QFD, service, theme park.

1. Company Profile of MD Robotics

MD Robotics, formerly known as the Spar Space Systems division of Spar Aerospace, Ltd. is a Canadian supplier to NASA with a well-established reputation for creating the world's most futuristic space robotics. Their skill in precision movement robotics made them the supplier of choice to re-create one of nature's most fascinating and magnificent creatures ever - the dinosaur. MD Robotics, in cooperation with Universal City Development Partners (UCDP) of Orlando, Florida designed and built three state-of-the-art robotically animated dinosaurs, the first of which was delivered February 1999.

MD Robotics' expertise was gained initially in the development of the space shuttle Canadarm used to manipulate cargo in and out of the shuttle's cargo bay. Although they had no previous experience with theme park attractions or dinosaur robots, they accepted the challenge to combine talents with Universal Creative and Hall Train Studios to provide life-like, large-scale, highly re-[1]

Andrew Bolt, the Program Manager, assembled a cross-functional team consisting of himself, some key engineers with skills in mechanical, hydraulic, controls, software and electrical design

[1] "Spar brings prehistoric creature to life." Canada NewsWire press release, March 10, 1999. http://www.newswire.ca/releases/March1999/10/c3114.html

from MD robotics, the paleo-artist Hall Train and the customer. Bolt considered QFD an important tool for translating vague imagery-based requirements from the animator's storyboards into the detailed specifications needed to accurately budget resources, design, and build the creatures. In conjunction with QFD expert Glenn Mazur of Japan Business Consultants of Ann Arbor, Michigan, a unique QFD template was formed and executed in just three weeks.

2. Why QFD?

Quality Function Deployment is a unique system for developing new products which aims to assure that the initial quality of the product or service will satisfy the customer. In today's turbo economy, traditional design methods that rely on extensive concept and market testing and multiple rollouts take too much time and increase risk that copycat products enter the market first. Best efforts driven by internal requirements risk failure to recognize important customer needs. The tools and methods can reduce these with a robust, traceable, and structured system of planning. Further, QFD can be customized to a specific project, whether it is a product, a service, software, or as in this case, a combination of all three.

QFD is the only comprehensive quality system aimed specifically at satisfying our customer and as in this case, our customer's customer (the theme park visitor). It concentrates on maximizing customer satisfaction (positive quality) and eliminating dissatisfaction (negative quality). QFD differs from traditional quality methods that focus on zero defects; after all *nothing wrong does not mean anything is right.*

QFD focuses on delivering positive value by seeking out both spoken and unspoken needs, translating these into actions and designs, and communicating these throughout each organization on the value chain to the end customer (the theme park visitor). Further, QFD allows customers to prioritize their requirements and benchmark us against our competitors. Then, QFD directs us to optimize those aspects of our products and services that will deliver the greatest competitive advantage. No business can afford to waste constrained financial, time and human resources on things customers don't value or where they are already the clear leader.

2.1 History of QFD

Quality Function Deployment began thirty years ago in Japan as a quality system focused on delivering products and services that satisfy customers. To efficiently deliver value to customers, it is necessary to listen to the "voice" of the customer throughout the product or service development process. The late Dr. Shigeru Mizuno, Dr. Yoji Akao, and other quality experts in Japan developed the tools and techniques of QFD and organized them into a comprehensive system to assure quality and customer satisfaction in new products and services [Mizuno and Akao 1994, Akao 1990].

In 1983, a number of leading North American firms discovered this powerful approach and have been using it with cross-functional teams and concurrent engineering to improve their products, as well as the design and development process itself [Akao 1983, King, 1987]. Service organizations have also found QFD helpful. One of the authors, Mazur, used QFD in 1985 to develop his Japanese translation business, **Japan Business Consultants**, and saw revenues increase 285% the first year, 150% the second year, and 215% the third year [Mazur 1993]. QFD was an important part of **Florida Power & Light**'s successful bid to become the first non-Japanese Deming Prize recipient in 1990 [Webb 1990] and in the 1994 Deming Prize awarded to **AT&T Power Systems**. QFD has been successfully applied healthcare since 1991 at **The University of Michigan Medical Center** [Gaucher and Coffey 1993, Ehrlich 1994], **Baptist Health System** [Gibson 1994, 1995], and other leading institutions. Interesting service applications also include the development of an engineering TQM curriculum at **The University of Michigan College of Engineering** [Mazur 1996a] and the application to employee satisfaction and quality of work life at **AGT Telus** [Harries et al 1995], and in small and medium enterprises [Mazur 1994]. Integrating service and product QFD was a hallmark of the study done by **Host Marroitt** to improve their breakfast service at US airports [Lampa and Mazur 1996, Mazur 1996b].

QFD has been heralded for such benefits as promoting cross-functional teams, improving internal communications between departments, and translating customer requirements into the language of the organization. Understanding customer requirements appears to be one of the weakest links in product and service design. In a survey of 203 projects at 123 industrial companies, 13 typical new product development process activities were rated by managers in terms of what percentage of projects they actually did the activity, and on a ten point scale, how well they performed the activity. Least performed (25.4% of the projects) was a detailed market study of customer requirements, and when it was done, the quality of work was graded a 5.74 out of 10 [Cooper 1993].

Many product developers explain this by saying that customer requirements are often too vague, never mentioned, change during the project, and even when met, are frequently not what customers want to buy. In QFD, several tools are employed to clarify vague requirements, discover hidden ones, and prevent changes or misunderstandings by correctly analyzing their root benefits [Mazur 1997, Rings et al 1998]. Prompting the development of these tools was a study done in Japan in 1984 that demonstrated that there were different types of requirements that needed different approaches to understand [Kano, *et. al.*, 1984].

2.2 Kano's Requirements

There are three types of customer requirements to consider to understand how meeting or exceeding their expectations affects satisfaction (Figure 1).

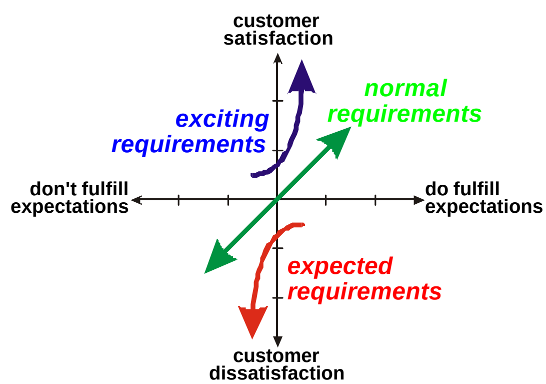


Figure 1. Kano's Model of Customer Requirements

Normal Requirements are typically what we get by just asking customers what they want. These requirements satisfy (or dissatisfy) in proportion to their presence (or absence) in the product or service. Fast delivery would be a good example. The faster (or slower) the delivery, the more they like (or dislike) it.

Expected Requirements are often so basic the customer may fail to mention them - until we fail to perform them. They are basic expectations without which the product or service may cease to be of value; their absence is *very* dissatisfying. Further, meeting these requirements often goes unnoticed by most customers. For example, if coffee is served hot, customers barely notice it. If it's cold or too hot, dissatisfaction occurs. Expected requirements *must* be fulfilled.

Exciting Requirements are difficult to discover. They are beyond the customer's expectations. Their absence doesn't dissatisfy; their presence excites. For example, if caviar and champagne were served on a flight from Detroit to Chicago, that would be exciting. If not, customers would hardly complain. These are the things that wow the customers and bring them back. Since customers are not apt to voice these requirements, it is the responsibility of the organization to explore customer problems and opportunities to uncover such unspoken items.

Kano's model is also dynamic in that what excites us today is expected tomorrow. That is, once introduced, the exciting feature will soon be imitated by the competition and customers will come to expect it from everybody. An example would be the ability to have pizza delivered in thirty minutes. On the other hand, expected requirements can become exciting after a real or potential failure. An example might be when the passengers applaud after a pilot safely lands the airplane in rough and stormy weather.

The Kano Model has an additional dimension regarding which customer segments the target market includes. For example, the caviar and champagne that's exciting on the domestic flight might be expected on the Concorde from New York to London. Knowing which customer segments you serve is critical to understanding their requirements.

Thus, eliminating problems handles expected requirements. There is little satisfaction or competitive advantage when nothing goes wrong. Conversely, great value can be gained by discovering and delivering on exciting requirements ahead of the competition. QFD helps assure that expected requirements don't fall through the cracks and points out opportunities to build in excitement.

In summary, Kano found that the exciting needs, which are most tied to adding value, are invisible to both the customer and the provider. Further, they change over time, technology, market segment, etc.

Understanding these requirements is best done by the QFD team going to the *gemba (*where the customer interfaces with the service) to observe, listen, and record the problems customers experience and the opportunities they wish to seize. Going to the gemba can be difficult for those who are used to seeing things from an internal point of view. They tend to see more process problems and solutions than customer needs. The tools of QFD help the team see the world from the customer's point of view.

3. Triceratops Encounter at Universal Studios Florida Island of Adventure

The movie *Jurassic Park* included an encounter with a sick Triceratops lying on her side. In the theme park attraction, a veterinarian attends to a sick but standing “Sarah” who seems to acknowledge visitors to her paddock where she is being examined. The 24 foot Triceratops looks, feels, acts, and even smells like a real animal, complete with breathing, blinking and pupil dilation, flinching, sneezing, drooling, and excreting. Visitors are never more than six feet away and can even pet her.

Given these encounters, the overall goal was to make a creature more believable and lifelike than any before. State-of-the-art at that time was the DinoAlive exhibit at an Osaka Japan museum, that relied on hydraulics to give them smooth, quick movements. The creature was designed by Vickers Inc. of Troy Michigan [Horgan, Gottschalk] which set a very high benchmark for realism of motion and appearance. For example. the 40 foot high Tyrannosaurus Rex could move from a resting position to fully erect in only 1 ½ seconds. The Jurassic ride in Hollywood also reflected where the industry was in June of 1996. The animals were fairly realistic but not convincing especially if you were able to stop the show and examine them closely. There was also a great concern with reliability. Thus, very stringent requirements were made so those close encounters such as petting would be thoroughly convincing.

3.1 QFD Template

As a design method, QFD is no cookie cutter approach. A project worth doing well deserves to have QFD tailored to the needs of the company, the team, the customers, and the customer's customers. QFD was used in the conceptual stage to bridge the gap between the artist and the engineer so the process was really tailored to suite the "skunk works" fast turn-around working environment in which the program ran.

The conceptual design Scope of Work document that was used to drive the QFD study specified that the outcome should include such specifications as degrees of freedom of movement, maximum velocity, range of motion, skin characteristics, etc. These were to correspond to various scenarios that the animators portrayed in some 60 storyboards which included such activities as sneezing, playing, moving legs, etc. Given the time and cost budgets, the MD Robotics team wanted to put its earliest efforts on the most important aspects of the dinosaur. The scope of work, however, did not indicate that any one storyboard activity was more critical than another – they were all equally important. Also problematic was the fact that for a company building space and defense components, translating the requirement of "sneezing" into an animatronic design not something their engineers had done before.

After an initial QFD introduction, Mazur's task was to customize the QFD process to deliver these needs. Bolt led a review of the Scope of Work document, and three key elements emerged:

1. achieve a clear understanding of the experience/benefits Universal wished to achieve
2. trace these benefits into engineering requirements
3. translate the engineering requirements into cost effective conceptual designs.

To clarify the customer requirements, we began a Voice of Customer Analysis of the Scope of Work document. The Voice of Customer Table – 1 (Customer Context Table) was first used to break down the details of the Scope of Work into singular statements and to then reword them with regards to the context of use. The Voice of Customer Table – 2 (Customer Voice Table) was then used to sort the statements in first as benefits vs. features, and then to detail the features into additional categories that then became the axes of the subsequent matrices. A deployment flow chart is shown in Figure 2.

3.2 Voice of Customer Analysis

The Voice of Customer Table – 1 (VOCT1) is commonly used to clarify complex customer requirements, particularly ion the context of use of the product or service. Context is easily described by the 5W1H (who is using, what is it used for, when is it used, why is it used, and how is it used). An excerpt from the VOCT1 for end product requirements is shown in Table 1.

The Voice of Customer states "animal-like reactions to the guests" who are described as families with elementary school age children visiting the Triceratops Encounter paddock after experiencing the thrill rides of the park. The reworded data reduces the complex requirement into singular terms to address the contextual concerns. Simply put, this attraction must not be a let-down after action rides of the park, and must keep the interest of children ranging from young enough to be amazed by seeing a "live" dinosaur to young teens amazed to see something so lifelike in terms of both appearance and behavior. The reworded data begins the process of analyzing the voice of customer into such details.

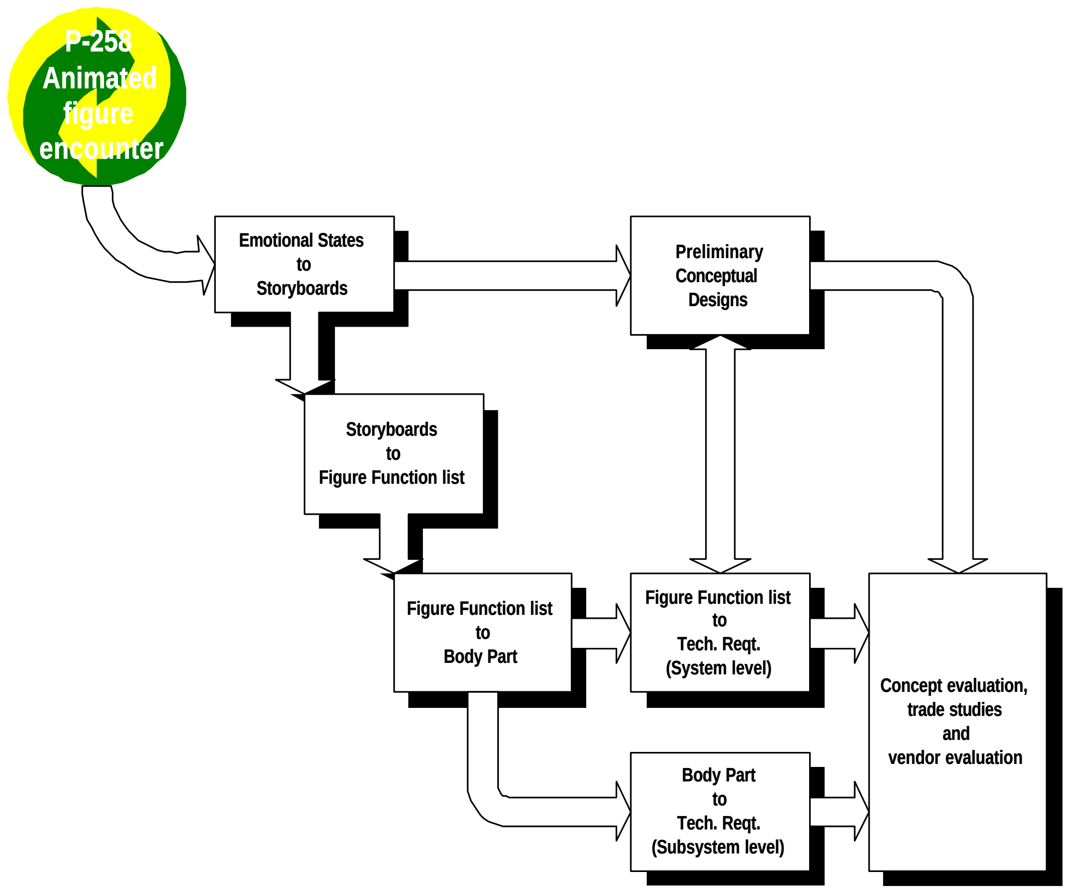


Figure 2. QFD Flow Chart for Triceratops Encounter

Table 1. Voice of Customer Table - 1 (Customer Context Table) (partial)

VOC from Scope of Work	Context of Use (5W1H)	Reworded Data
The close proximity of guest-to-dinosaur dictates fluid movements, non-cyclical programs, low noise, realistic skins, animal like odors, and animal-like reactions to the guests.	Who: Families with K-8 children. What: Entertainment. When: After thrill rides. Where: An animal paddock area behind the discovery Center in Isla Nublar, home of Jurassic Park. Why: Amaze children. How: Guests are allowed limited, supervised interaction, (close contact and some direct contact of specific body areas) with dinosaurs.	Smooth movement. Quiet movement. Looks realistic. Smells realistic. Reacts realistically to guests. Responds to touch. Non-repetitive movement. One-on-one personal experience. Like a zoo. Interacts with guests. Appears alive. Appears alert.

The Voice of Customer Table – 2 (VOCT2) sorts these reworded data on whether they are describe a feature of the product or the benefit to the customer the feature must provide. Product features are further broken down into performance measurements, functions, reliability, safety, technologies, materials, components, etc. In this case, for conceptual design, the categories were storyboards, body motions, technical requirements, and concepts. See Table 2.

Table 2. Voice of Customer Table – 2 (Customer Voice Table) (partial)

Benefit	Storyboard	Body Motion	Technical Req	Concept
Looks realistic	Variable, so revisits are different	Non-repetitive	Resistant to outdoor elements	Concealed controls

These VOCT tables structured and analyzed both hidden and known requirements of the final product. Voice of Customer Analysis in QFD also has the tools and methods to move up and down the customer value chain and can translate and link the requirements of end user (guests), operator of the attraction, maintenance, installers, theme park management, and animators. One method for doing this is called "going to the gemba" or to the place where the product is put into use. It Here we have features and benefits for the end product, but what of the benefits to the consumer? Since no consumer had ever seen a moving dinosaur, their interpretation of "realistic" was limited to their personal imagination based on illustrations, cartoons, or other robotics. It was relatively easy to see that the operator, maintenance, installer, management, and animator gembas could be visited at an existing amusement park, but what about the dinosaur gemba?

As a vendor to the space industry, MD Robotics engineers were adept at simulating environments. It is well known that swimming pools and high altitude drops are used to simulate the micro-gravity of space, and are frequently used by aerospace vendors during design. To simulate the Triceratops Encounter, they visited a petting zoo in Toronto where they could observe children encountering live animals. This helped them better understand what the expectations and interactions children would be familiar with. What they learned was that the general public look for anthropomorphic qualities in the animals; in other words they attach human emotional states to the actions of the animals. The other point that was noted was that with the dawning of the information age, people and specifically children, are incredibly knowledgeable when it comes to dinosaurs. To have a convincing animal, the stance, motion and look must be correct with the state of knowledge within the paleontology world today.

From this gemba, the emotional states detected were structured with an Affinity Diagram and Hierarchy Diagram. See Table 3. These emotional states were presented to the animators for prioritization based on the contribution of each emotional state to making the attraction popular and enjoyable. An interesting dichotomy arose because the animators placed a higher priority on a natural looking effect which tended to emphasize gross body motion associated with distant viewing, while guests at the zoo wanted more contact with the head which tended to emphasize detailed head sub-mechanisms such as tongue, nostrils, etc.) Mazur recommended using sales points in the House of Quality to re-emphasize those emotional states that were more visitor-contact oriented.

The main means the animators used to convey the creative requirements to the MD Robotics team was through storyboards. An example of these is shown in Figure 3.

Table 3. Hierarchy of Emotional States (partial)

Quiet	Bored
	Sleepy
	Shy
Agitated	Aggressive
	Distressed
	Startled
	Surprised
	Frightened
	Nervous
	Defensive
Active	Nosy
	Curious
	Playful
	Happy

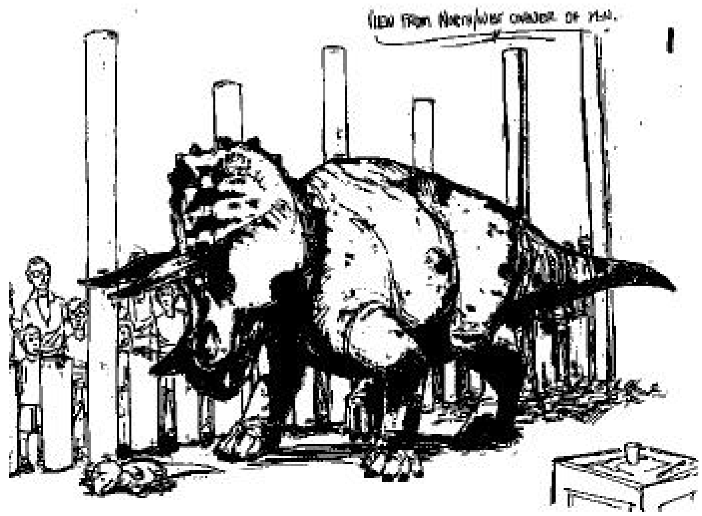


Figure 3. Example of Storyboard.
© Storyboards by Hall Train (August 1996)

3.3 Emotion Deployment

The emotional states prioritized by both the Hall Train animators and the petting zoo guests were then used to prioritize the animators' 65 storyboards in order to determine which postures and positions most strongly correlated with the most important emotional states. Using this process we formed the emotional state vs. storyboard matrix. This enable the design team to get a feeling for how important each storyboard was to the show. Table 4 shows this deployment matrix.

Table 4. Emotional State vs. Storyboard Matrix (partial)

Storyboard #	**7**		**8**	**52/54/ 55**	**53**	**56**	**59/60/ 29/58**	**61**	**62/63**	**1 to**	**8/64/6 5**	
Emotional States	defensive posture		angry/aggressive	visual response	blinking	nostril flare/sniffing	Skin twitching/flexing motions 1/2	skin temperature	breathing 1/2		poses and views	**IMPORTANCE**
Distressed	9		9	9	9	9	9		9			2
Startled				9	9	9	9		3			3
Surprised				9	9	9	9		3			3
Playful				9	9	9	9		3			3
Happy				9	9	9	9		3			4
Absolute weight	83		69	339	351	327	351	0	201			
Sales Point weight	1		1	1.2	1.5	1.5	1	1	1.2			
Storyboard weight	**1.5**		**1.2**	**7.2**	**9.3**	**8.6**	**6.2**	**0.0**	**4.2**			

In this matrix, the emotional states are weighted on a 1-5 scale, 5 being most important. The degree of correlation between each body motion and emotional state are indicated in the intersecting cells of the matrix, using the values of 1 for some correlation, 3 for average correlation, and 9 for strong correlation. The emotional state weight is then multiplied by the correlation value in each cell, and the results are summed column by column (absolute weight). This tells which body motion has the most and the strongest overall contribution to the most important emotional states.

As mentioned above, there was a dichotomy between the animators and the petting zoo visitors we observed, and a "sales point" was factored in to add more importance to head contact storyboards. In QFD, sales points are that further emphasize exciting requirements multipliers (1 not exciting, 1.2 exciting, 1.5 very exciting). The absolute weights were then multiplied by the sales points, and normalized to a percentage to yield the Storyboard weights. The Storyboards with high weights are critical to conveying an exciting show to the visitors. For example, the triceratops flaring its nostrils is crucial to conveying it is happy or startled. (Figure 4)

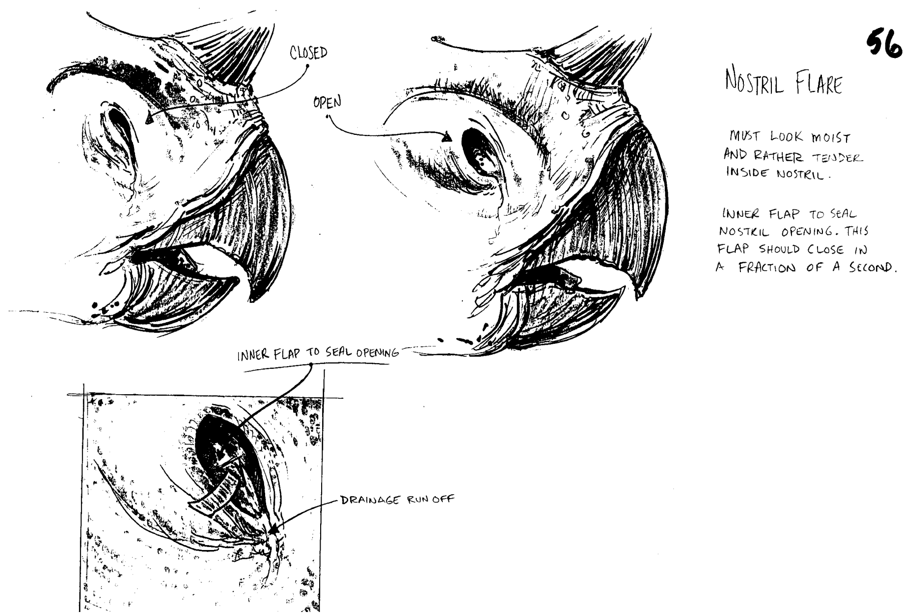


Figure 4. Storyboard 56. Nostril Flare.
© Storyboards by Hall Train (August 1996)

3.4 Body Deployment

The QFD process was then used to take this down a further level to get the relationship between the storyboards and body motion then from the body motion to detailed body parts. The main benefit in doing this was to see the relevance of the body parts to the emotional states. Because the emotional states were now weighted, this ensured us that we would spend the time on the most relevant physical components of the dinosaur.

Body Motions were structured with an Affinity Diagram and Hierarchy Diagram (Table 5) and then were joined in a matrix with the weighted Storyboards.

Table 5. Body Motion Hierarchy (partial)

Muscle	Skin	Shudder
		Twitch
		Temperature change
	Buttocks	Tense/Release
		Bulge/Expand
Appendages	Front toes	Spread
		Curl
	Neck	Yaw
		Roll
Facial Parts	Nostrils	Flare
		Sniff/Inhale
		Air blast
		Spray
		Moisten
	Eyes	Translate

Table 6. Storyboards vs. Body Motions Matrix (partial)

Body Motions / Storyboards			left front leg 3 pitch	lfl yaw	lfl roll			Skin articulation		**Storyboard weight**
7	defensive posture		3	3	3					1.5
8	angry/aggressive		9	9	9					1.2
42	step backwards		9	9	9					4.2
49	throat movement									2.3
50	tongue movements									4.2
51/57	jaw movement 1									5.2
52/54/55	visual response									7.2
53	blinking									9.3
56	nostril flare/sniffing									8.6
59/60/29/58	Skin twitching/flexing mot		/2							6.2
62/63	breathing 1/2									4.2
to 6/18/48/64/65	poses and views									0.0
	Absolute Wt.		397.4	397.4	397.4			0.0		
	Body Motion Weight		2.93	2.93	2.93			0.00		

The Storyboard vs. Body Motions Matrix (Table 6) shows the correlation of each body motion to displaying the theme of the storyboard and then weights the body motions using the same process as in Table 4. The first row, for example shows that "left front leg 3 pitch" plays an average role in a defensive posture. In Table 6, the body motions have been rearranged in descending order of importance.

Body Motions were then deployed into specific body parts indicated in the Primary Structure of the Triceratops (Figure 5). A Body Motion to Body Parts Matrix translated the body motion weights into body part weights (Table 7). This would tell us, among other things, how big a role does head base structure play in the body motion function of head movement.

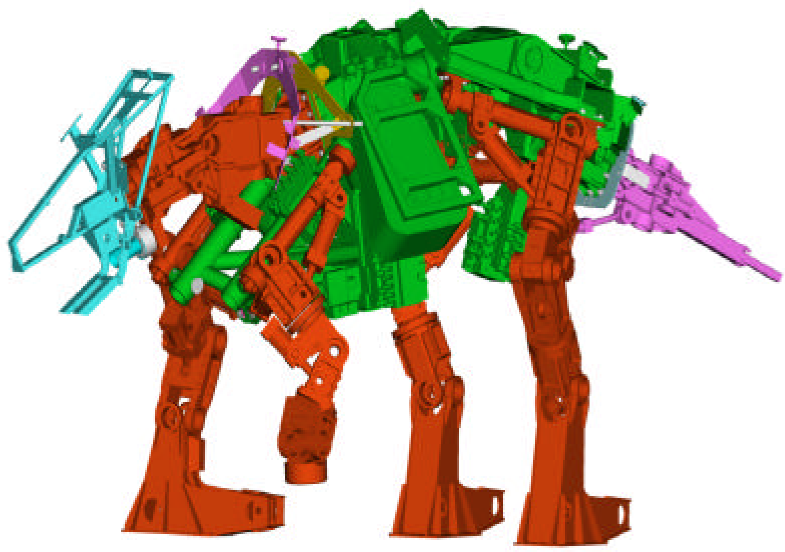


Figure 5. Primary Structure of Triceratops

Table 7. Body Motion vs. Body Parts Matrix (partial)

Body Parts	HEAD ASSEMBLY												NECK				U
Body Motion	head base structure	eye mechanism	tongue mechanism	nostril mechanism	mouth mechanism	breathing mechanism	jaw muscle mechanism	cheek muscle mechanism	frill muscle mechanism	ear muscle mechanism	head shell and skin	neck mechanism	upper neck muscle	lower neck muscle	neck shell and skin		lung and rib mechanism
left front leg 3 pitch																	
lfl yaw																	
lfl force into ground																	
right front leg 3 pitch																	

3.5 Engineering Requirements Deployment

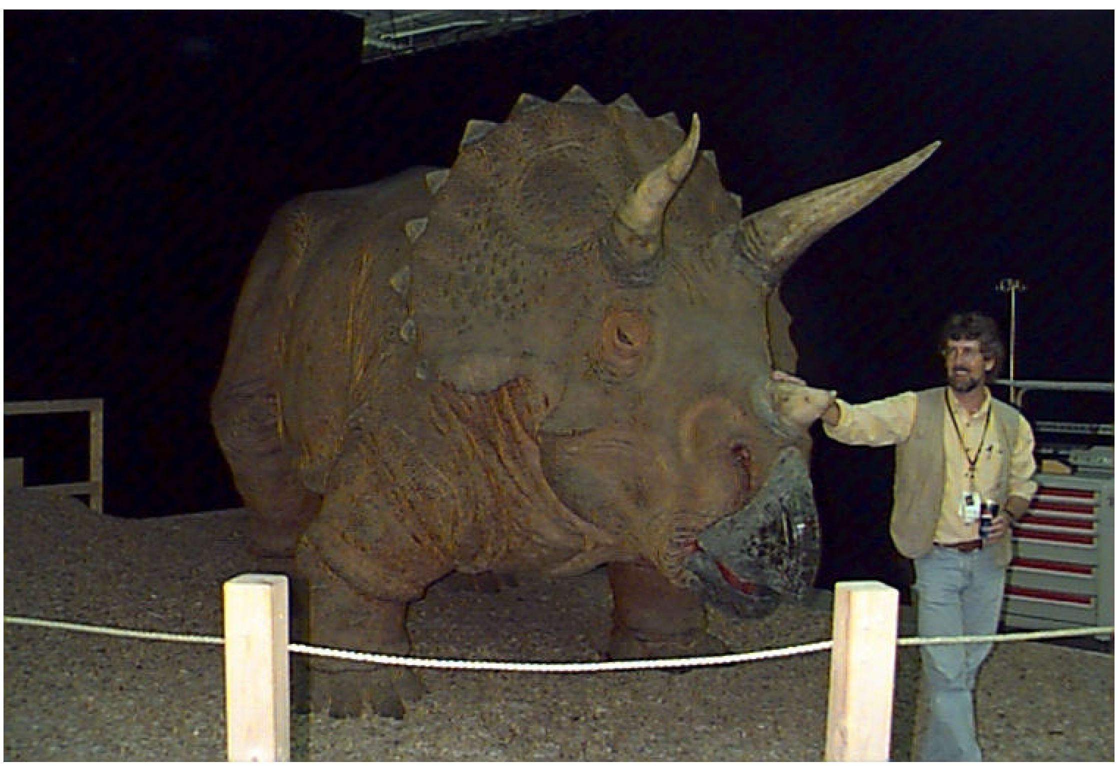
Engineering requirements which would lead to design specifications were then developed and structured in a hierarchy diagram (Table 8).

Table 8. Engineering Requirements Hierarchy (partial)

Static mech.	Static balance	
	Tip deflection	
	Mass	
	Reaction loads	Geometry
		Bearing loads
Kinematics	Joint angle of travel	
	Joint acceleration	
System design and architecture	Pneumatic power	Pneumatic flow rate

Both the weighted body motions and the weighted body parts were then deployed in matrices to determine which engineering requirements required the most exacting specifications. These matrices are not shown. Additionally, matrices to identify and design out potential failure modes were created. Later in the study, these charts helped simplify certain systems and components resulting in lower cost, faster design, and improved reliability.

The May 1999 opening of the new Triceratops Encounter at Universal Studio's Jurassic Park attraction prompted U.S. News & World Report to write "these three creatures snort, stomp their feet – even pee. Ask the 'keeper' if you can pet them. It's up to him or her to decide."[2] (Figure 6)



being reviewed by the customer.

[2] Travel section. "Triceratops Encounter." *U.S. News and World Report.* May 10, 1999 p. 71.

4. Conclusion

Quality Function Deployment has been used by quality conscious organizations around the world for over 30 years. Its adaptability to nearly any product development project has earned QFD the reputation of being a methodical approach to assure customer satisfaction with the quality of new products and services.

There has been a steady upstream migration of QFD since Akao introduced the method in the 60s. For the first ten years, QFD focused on internal deployments within the company's operations to assure that quality requirements are accurately communicated throughout the development and production process. In its second decade of use, QFD incorporated external analyses of customer requirements based on examining actual uses by the customers. In its third decade, we now see QFD being in the initial phases of product concepting [Rings et al 1998]. Further, QFD is now being used to integrate the hardware, software, service, and process aspects that are common in most products today.

MD Robotics has continued to apply QFD to other products in its traditional lines of business with great success. Unlike the dinosaurs, it is expected that their use of QFD will continue to evolve in order to assure that their customer driven focus will never become extinct.

About the Authors

Andrew Bolt has worked in the aerospace industry for 15 years, initially as a consultant to Spar Aerospace then as a member of the management team. He managed the design of the next generation space station robotic arm. He also was responsible for the design and build of the mobile base on which the space station arm is stored and performs maintenance tasks. Andrew managed the mechanical engineering division and was executive assistant to the director of operations within Spar Aerospace. This is where exposure to the QFD process occurred. The Triceratops Encounter program was an excellent application of this process. This combined Andrew's engineering, process and sculpting interests. Andrew Bolt managed that program from inception to completion and now is managing the strategic development of theme park robotics within the newly renamed MD Space and Advanced Robotics Company. He can be reached at +1 905-790-2800 x 4095, by fax at +1 905-790-4430, by email: abolt@spar.ca or abolt@mdrobotics.ca (after July 1999)

Glenn Mazur has been the "voice" of QFD since its early inception into the United States. He has worked extensively with the creators of the QFD methodology, Drs. Shigeru Mizuno and Yoji Akao, since that time. He is a pioneer in the application of QFD and TRIZ in service industries. He currently holds the following positions: President of Japan Business Consultants, Ltd., Executive Director of the QFD Institute, Executive Director of the International Council for QFD, Chairman of the North American QFD Symposia, Adjunct Lecturer of TQM at the University of Michigan College of Engineering. He is also a 1998 recipient of the Akao Prize for Excellence in QFD and is one of two designated trainers of QFD Black Belts in North America. He can be reached at +1 734-995-0847, by fax at +1 734-995-3810, by email: glenn@mazur.com, and internet: http://www.mazur.com.

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