New Lanchester Theory for Requirements Prioritization

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Abstract

New Lanchester theory links Business Objectives to market share using a quantitative model. It can be effectively used for deciding which new features to add to software products for winning a business.

This paper introduces the New Lanchester Theory and explains its use for effectively prioritizing requirements. It explains the theory for requirement experts and shows how the New Lanchester Theory relates to Quality Function Deployment, the Six Sigma way of managing requirements,

1. Introduction

New Lanchester Strategy is better known among marketing professionals than among ICT experts managing requirements for software. However, in order to finding all missing requirements, and prioritize them, New Lanchester Theory is helpful in the ICT Industry as in many other industries. Although New Lanchester Theory is scarcely known outside of Japan, and kept as a trade secret rather than published, some literature is available and a few references exist that we can refer to in the related talk.

2. The New Lanchester Theory

How do you win customers for a new, improved offer? You must understand how customers decide, and you must target at their decision process. It means that the offered products or services must become irresistible for the target market.

2.1. A Scientific Method

The New Lanchester Theory is a typical scientific method, as outlined in Lucio Russo's excellent book "The Forgotten Revolution" [11]. It uses a theory to predict the outcome of commercial undertaking, and we use evidence from practical applications of the theory to validate this approach.

2.2. Focusing Forces

Frederick William Lanchester was born 1868 in London and educated as engineer. He created aircrafts, gas motors, disk brakes, four-wheel drives, and servo drive, and received 236 patents. In 1916, while he devised the operational strategy for the Royal Air Force, he formulated the 1st and the 2nd Law of Lanchester, which describe forces needed for winning military battles. This was particularly helpful for the US in the Pacific campaign against the Japanese fleet. Until the late 20th century the Lanchester Laws were used to predict the outcome of military battles.

The „New Lanchester Approach" originated in Japan, where Nobuo Taoka and Shinichi Yano adapted the two laws of Lanchester for strategic and tactical marketing [7], [10]. Competition in the market is seen as sort of a battle, where a sales organization only can win when they can convince customers to buy their products. Instead of counting won battles, the measurement for marketing is the market share for the product or service.

2.3. The New Lanchester Strategy

Similar to Quality Function Deployment (QFD), New Lanchester Strategy uses Customer's Needs profiles for distinguishing between high and low priority needs. Profiles are always relative to each other; they do not provide absolute values usable for benchmarks.

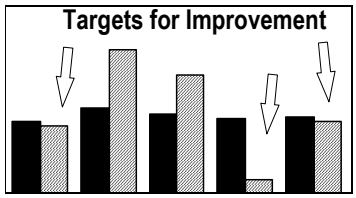

Figure 1: Profiling Needs Fulfillment

The New Lanchester Strategy means finding those customer's needs that are not met well enough. If a competitor wants to stay in the market or gain market share, he needs to improve his products for beating competition and overcoming obstacles and resistance.

Once we know which market segments to attack with what kind of product parameters, we can establish our new target profile from a numerical combination based on the current market preference and the competition performance.

2.4. Predicting Market Share Battles

The two laws of Lanchester allow predicting, who wins a market share contest.

First we look after the traditional one-to-one contest as described so exquisitely in Homers Trojan War. Success depends from the individual performance only. He, who has better weapons and more strength, wins.

The following formula describes the likely outcome of the battle:

$$m_0 - m = E(n_0 - n)$$

where m_0 counts the initial number of fighters from one parts, n_0 the number on the controversial site, and m, n the fighters left after the fight, on both sides.. E is the „Exchange Rate", the relation of the respective weapon strength.

Balance is reached when the weapon strength E corresponds to the number of casualties:

$$E = \frac{(n_0 - n)}{(m_0 - m)}$$

The 2nd law in turn takes mass destruction effects into account, such as neuronal activity of a brain cell that influences a multitude of other neighbor neurons; similar to modern mass communication media.

In this case the law holds in square form:

$$m_0^2 - m^2 = E(n_0^2 - n^2)$$

Equilibrium is reached when the effectiveness factor E equals the ratio of the square differences:

$$E = \frac{(n_0^2 - n^2)}{(m_0^2 - m^2)}$$

As a proof idea for this formula, imagine two groups of brain cells: Group A with three, group B with two neuronal bundles. Each of them fires electrical pulses and thus influences its neighbor neuron cells.

Each cell of group A is exposed to neuronal fire from two active neighbor cells that hit them with probability $^1/_3$.

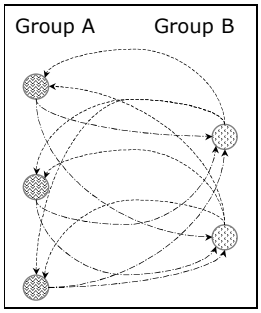

Figure 2: The Neuronal "Battlefield"

On the other hand, a member of group B is "under fire" by three active neurons. It is hit with probability ½.

The effectiveness factor becomes

$$E = \frac{^2/_3}{^3/_2} = \frac{2*2}{3*3} = \frac{4}{9} = \frac{(n_0^2 - n^2)}{(m_0^2 - m^2)}$$

Thus the group A benefits from the double amount of effectively compared to group B, with only 50% more members. If the 2nd Law of Lanchester holds, scarce resources can significantly be optimized.

2.5. „The Strategy of the Weak"

If your product features are weak against the competition, you still can outperform competition locally when you can create a niche, e.g., near the customer, or speaking local languages and knowing local habits. This corresponds to additional customer's needs criteria that you can explore from a weak position. Custom software development often is the strategy of the weak.

2.6. „The Strategy of the Strong"

On the contrary, if you hold in a market with more than two competitors a market share above 41.7%, you can apply the Strategy of the Strong. The goal is to block smaller competitors from market niches. If you cannot do better, you typically announce new developments, even if you don't really want to invest, than letting competitors gain market share. As soon as your market share falls below the "magic barrier" of 41.7%, your business goes into trouble and margins fall. We have seen many examples of the Strategy of the Strong in the past.

Another popular strategy is to let smaller competitors explore new market niches and then buy them, including their skills and market shares.

3. Managing Requirements by Six Sigma

It is well known how to manage software requirements with Quality Function Deployment (QFD) [1]. It is probably less known that QFD actually uses statistical methods [5] to deploy requirement profile according customer priorities. QFD is a method to construct linear *Transfer Functions* that transform the profiles of technical requirement into profiles for business requirement for software.

One of these Transfer Functions that is part of the Deming chain for requirements management, according the Best Practices Standards for QFD defined by the German QFD Institute, is the Competitive Analysis matrix. More on the Deming Chain see [2].

3.1. The Kano Analysis

The most popular method for Voice of the Customer (VoC) analysis is the Kano method. The Kano method compares customer satisfaction with technical excellence and can be used to prioritize customer's needs, or any other level of business or technical requirements. In our case, we use the Kano method to find priorities for the customer's needs.

Table 1: Customer's Needs for a Web Service

CN-F Functionality	CN-F.1 Information Content
	CN-F.2 Trustworthiness
CN-Q Quality	CN-Q.1 Up-to-date Functionality
	CN-Q.2 Ease of Use
	CN-Q.3 Compelling Service

For demonstration purpose, we use a small sample requirements model. Assume a provider of a Web Service wants to meet the Customer's Needs shown in Table 1: Customer's Needs for a Web Service.

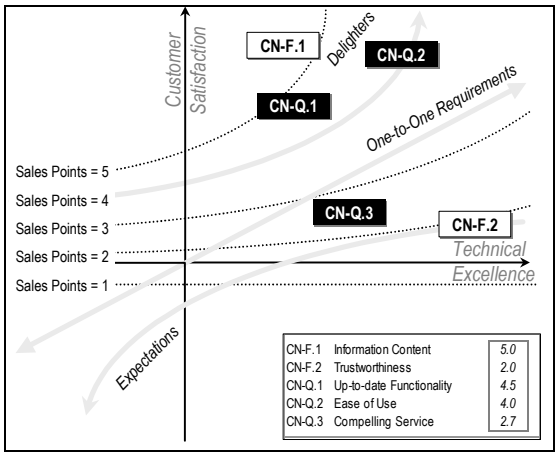

Figure 3: Kano Assessment for the Web Portal

In a Kano Workshop, a joint team from marketing and developers provided the assessment shown in Figure 3: Kano Assessment for the Web Portal.

It can be seen from the picture that the team put CN-F.1: "Information Content" most prominent for achieving customer satisfaction and considered CN-F.2: "Trustworthiness" requiring high technical excellence. This translates into the customer's needs profile from Figure 4: Customer's Needs Profile.

		Weight
CN-F Functionality	CN-F.1 Information Content	2.6
	CN-F.2 Trustworthiness	2.6
CN-Q Quality	CN-Q.1 Up-to-date Functionality	2.2
	CN-Q.2 Ease of Use	1.5
	CN-Q.3 Compelling Service	2.1

Figure 4: Customer's Needs Profile

Note that this profile represents the "Sales Points", that is the value of related features in the sales process. A low value does not necessarily mean that it's not needed; it might be simply an expectation of the customer such as "Trustworthiness".

There are many other choices for assessing customer preferences such as questionnaires, following clicks, assessing responses and help desk complaints and wishes, see e.g., [7], [8].

The Kano method is the fastest way to prioritize requirements; the method depends whether we find a knowledgeable team that can agree on positioning requirements in the Kano grid.

3.2. The Transfer Function

According the New Lanchester Theory, the customer's needs are instrumental for the customer's decision to buy a product or use a service.

In case of our Web Portal it is possible to trace the frequency, how many times the portal had been visited and used by customers. Therefore we can use the New Lanchester strategy to find the true customer's needs profile as seen by the market.

The caveat is that market share in general is the result of a long period of competition and may not always reflect the current attractiveness of a service. For our Web Portal, we assume that the market share reflects the attractiveness for our target customers, and not some heritage characteristics like traditional name or well-established brand.

The Transfer Function for Market Attractiveness must explain why people choose to use some Web Service. To achieve this, we create the transfer function as a linear cause/effect matrix that compares how well each of the competitors involved meets customer's needs.

Market Attractiveness & Competition / Customer's Needs Combinator	Profile of Market Attractiveness & Competition	CN-F.1 Information Content	CN-F.2 Trustworthiness	CN-Q.1 Up-to-date Functionality	CN-Q.2 Ease of Use	CN-Q.3 Compelling Service
Our Service (19%)	2.2	5	9	8	1	5
C-1.1 Competition 1 - easy to use (16%)	1.9	5	3	6	9	3
C-1.1 Competition 2- all nice (19%)	2.2	6	7	6	5	7
C-1.1 Competition 3 - best in class (26%)	3.0	9	9	8	9	9
C-1.1 Competition 4 - struggling (9%)	1.0	2	3	3	4	5
C-1.3 Competition 5 - niche player (11%)	1.3	3	6	3	6	5

Figure 5: Competitive Comparison

This cause/effect Transfer Function matrix is filled column-wise, from top to bottom. A "9" indicates highest performance in a column; for instance, for CN-F.2, Our Service is as good as C-1.1 "Competition 3 - best in class", but better than all the others. Least performance is recorded as a "1", which unfortunately holds for Our Service for the criteria CN-Q.2: "Ease of Use".

3.3. The Convergence Gap

The Transfer Function **M** transforms the cause profile **x** into the effect profile **M(x).** Its transpose $\mathbf{M^T}$ transforms an effect profile **M(x)** into its cause $\mathbf{M^T(M(x))}$. In general, $\mathbf{M^T(M(x))} \neq \mathbf{x}$; otherwise we possibly could find causes from effects automatically. Then the world would be deterministic!

If $\mathbf{M^T(M(x))} = \mathbf{x}$, then **x** is an *Eigenvector* of $\mathbf{M^TM}$. Eigenvectors are well known as indicators for sensible cause/effect relations in physics and decision-making. For more information, see [11]. In Six Sigma, working with an Eigenvector on a Requirements Deployment Transfer Function means that we effectively can predict the impact of implemented requirements on the customer.

The respective quality metric is called the *Convergence Gap* [4]. It is defined as the residual between the profile **x** and its transfer transform $\mathbf{M^T(M(x))}$. If the Convergence Gap is small, this indicates that the Transfer Function identifies a good technical solution for the effects wanted, e.g., Customer's Needs. For the matrix in Figure 5: Competitive Comparison, it means that the selection of Customer's Needs is a valid explanation for the observed attractiveness of our service, expressed by its market share. In our example, the Convergence Gap is 0.18, relative to a maximum of 5.0 for totally opposed profiles, and to 2.04 when the matrix is not correlated at all. Thus the competitive analysis for the Web Portal example is sound.

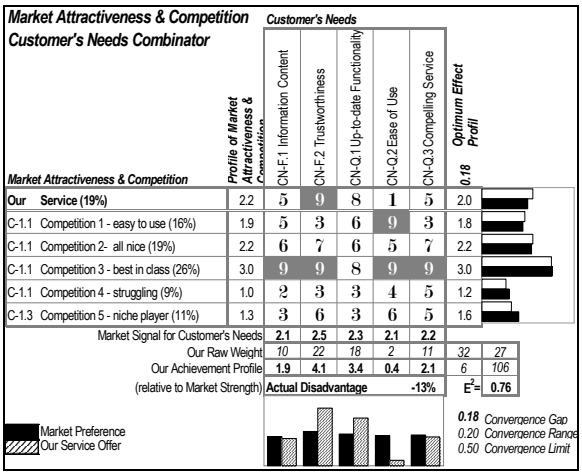

Figure 6: Competitive Advantage

In Figure 6: Competitive Advantage, the Transfer Function **M** describes how some Customer's Needs profile **x** impacts the observable market share **M(x),** the effect profile. This is computed by applying the matrix **M** on the profile **x**. However, we don't know x in the first instance. In order to get the market signal **x** for the five Customer's Needs using the transpose $\mathbf{M^T}$ of the Transfer Function **M** the black profile on the bottom represents the selected. This yields the expected effect on market share, since the Convergence Gap is small. The effect profile **M(x)**, is displayed black on the right-hand side graph.

We therefore can compare the Customer's Needs profile for the market signal with the one that we produce with our Web Portal. As can be seen from the graphics, there is significant room for improvement, shown in Figure 1: Profiling Needs Fulfillment. The effectiveness factor E^2 is 0.76, yielding a competitive disadvantage of -13% (= square root of effectiveness factor E^2 – 100%). With such performance, our Web Portal is likely to loose visitors and users.

With a market share of 19%, we are far from market dominance. The choices we have are:

- Go out of business, or
- Re-define our business, or
- Significantly improve our profile.

If we decide for the third choice, the New Lanchester Method effectively selects the development direction for improving the market share. We can optimize performance against competition by adding feature strength to selected Customer's Needs categories, and use the transfer function defined by the matrix shown in Figure 6 to predict market strength.

4. Using New Lanchester to set Goals

4.1. Finding Opportunities for Improvement

The 2nd law of Lanchester allows playing with the opportunities for improvement. For this, we deliberately can select the improvement ratio (in percent) needed for the various Customer's Needs.

For instance, we must eliminate the major weakness in CN-Q.2: "Ease of Use". Here, an improvement ration of 550% indicates that we have to re-design the user interface.

Two more areas need focus: CN-F.1: "Information Content" and CN-Q.3: "Compelling Service", with improvement ratio of 180% each.

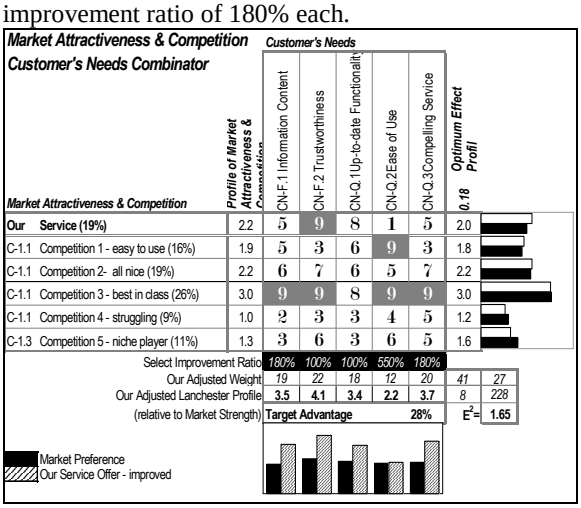

Figure 7: Setting Targets Using the Lanchester Profile

As shown in Figure 7, our development effort is expected to result in a competitive advantage of 28%; enough to get noticed in the market and thus starting a period of growth for the patronage of our Web Portal. Management decisions for the investment needed are based on solid facts.

The resulting "Lanchester Profile" corresponds with the result of the Kano method; however, on some aspects such as Trustworthiness, the prioritization weight may differ significantly.

4.2. Caveats

The most difficult part in applying New Lanchester Theory is getting data for customer attraction. If market share data is used, care must be taken that the market is actually in an equilibrium state. If product life cycle is too long, market share might just reflect the renewal cycles. Measurement scope must be actively managed to get reliable and repeatable results.

4.3. Applying New Lanchester Theory

Experiences made with the application of the New Lanchester Theory show that it not only provides a valid positioning products or services in the market with respect to Customer's Needs, it also can reliably predict the outcome of market initiatives, of product innovation, evaluation, and bids in competitive situations.

One of the big advantages of the theory is that it allows predicting and thus managing quantitatively the growth of a company. You can add as much features to your products or services as you need to continually grow your business.

New Lanchester Theory is part of the QFD Black Belt instruments and therefore available thoughout industries.

5. Examples

5.1. Swissair First Class

The former Swiss airline "Swissair" used New Lanchester Theory to revamp their First Class Service to become again the Number One in the world's airline business. Strong competition and growing financial difficulties, as well as bad management, had undermined its former good performance.

New Lanchester Theory was used as part of a Six Sigma Strategy to identify those service characteristics that were needed to convince customers again from the value of Swissair's First Class offering.

The theory predicted a 23% growth in margin gained from an increase of business while saving on cost at the same time; the result achieved after a year was 21%. Details can be found in [2].

Although the example is not from software industry, rather from services, it demonstrated the mechanisms needed to make New Lanchester work in practice.

5.2. GMC Software Technology

GMC Software Technology, a world-class provider of personalized customer communication software (Direct mail, bills, statements, etc.) uses it to steer its 30% – 50% yearly growth and outperform its competition. New Lanchester Theory was used to set priorities in Release Management for new features to be included in new releases needed to maintain and control business growth. We used it not only to win market share, but also to avoid winning too much market share, in implementing new features only at

such a rate that GMC remained able to manage growth. Details of GMC's approach have been published in various papers, for instance in [2] and [4].

6. References

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