INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'07
28 - 31 AUGUST 2007, CITE DES SCIENCES ET DE L'INDUSTRIE, PARIS, FRANCE

SENSITIVITY ANALYSIS OF AN EVALUATION METHOD FOR THE DETERMINATION OF THE SUCCESS POTENTIAL AND THE DEGREE OF INNOVATION

Thomas Weller, Hansgeorg Binz and Jobst Overkamp
Institute for Engineering Design and Industrial Design, Universität Stuttgart, Germany

ABSTRACT
The Institute for Engineering Design and Industrial Design at Universität Stuttgart developed a new evaluation method to determine the success potential and the degree of innovation of products and product ideas. This evaluation method was introduced at the ICED 2005 [1].
The algorithm of the evaluation method generates both an index for the success potential and the degree of innovation. A basic result of the examined pilot projects is that the evaluation is already possible at an early stage of the innovation process, from the moment that concrete customer requirements are known. However, first validation tests yielded some unexpected results. Although various products had been evaluated [5], the output indices for these products only differed slightly. The index for the success potential always reached almost similar high values, whereas the index for the degree of innovation levelled off at values below the expectations.
This led to an investigation of the evaluation method's sensitivity regarding the output indices depending on a change of the input parameters in order to improve its algorithm. The original evaluation algorithm was analyzed and several weak points were revealed. A new algorithm was developed which shows a more realistic behaviour and uses a wider range of the possible spectrum of results [7].
To verify the reliability of the new algorithm's results, first tests in industry projects have been started recently.

Keywords: Evaluation methods, innovation management, sustained innovation, product development, engineering design

1 INTRODUCTION
Innovative products are the key to success for all enterprises, especially in a competitive global market [4]. In reverse, it could be said that an innovation is only expedient if it does not only exhibit a technical novelty, but also contributes to the growth of a business company, which again leads to its economical success [6]. Hence, a main task for companies in all business segments is to develop innovative products and launch them successfully on the market [9]. Thus a product can be called "successful" if, compared to other products, it offers a higher benefit to both the customer and the manufacturer.
In order to launch successful products, a detailed knowledge of customer requirements and their conversion into product requirements is necessary. The exact fulfilment of customer requirements is essential for the product quality. For every enterprise, this results in the following basic questions:

- Have all customer wishes been accurately analyzed and implemented?
- How innovative is the product?
- What is the ranking of the product on a defined scale in comparison to competitive products?

In order to successfully develop innovative products, methods are necessary which are particularly related to the innovative parameters "novelty" and "successful commercialization" and which help to evaluate and select product ideas or solution principles within the product development process [2].

Therefore, a new evaluation method was developed and introduced at the ICED 2005. It is based on the following definition of innovation:
An innovation is the successful realization of a novelty, a creative idea or an invention with enhanced customer and manufacturer benefit [1].
First tests showed that the evaluation is possible from the moment when concrete customer requirements are known. However, these first validation tests also brought some unexpected results, which led to a sensitivity analysis of the method's algorithm.

2 EVALUATION METHOD

In the business economics sector several methods and surveys concerning innovation management and product evaluation exist [3], whereas no evaluation method could be retrieved, which considers the essential nucleus of an innovation, the product or idea itself, from a technical point of view [5]. This method focuses on the technical point of view and, therefore, aspects of economic efficiency are considered to a lesser extent only. Since the best possible fulfilment of customer requirements is the key to achieve a high customer benefit, the method first analyses the customer requirements and their conversion into product requirements. Therefore, elements of the QFD method are used and the technical importance of the product requirements is determined analogically to the "1. House of Quality" of QFD.
Additionally, customer and product requirements are analyzed with regard to their "importance of novelty" by answering the question: How much can the product be judged as new compared to already existing products (if the requirements are fulfilled)?
The results of this modified QFD are linked to five parameters which describe the influence on the product success. They are necessary for a comprehensive evaluation with regard to the enhanced manufacturer's benefit of an innovation and take into account the market situation, the producibility, ideality and economic efficiency of the product, as well as the probability of fulfilment of the product requirements [1].
As results the evaluation algorithm identifies the "success potential" of the product or idea (viz. the chance of market penetration) and finally the "degree of innovation", which is determined as the share of novelty of this success potential (Figure 1).

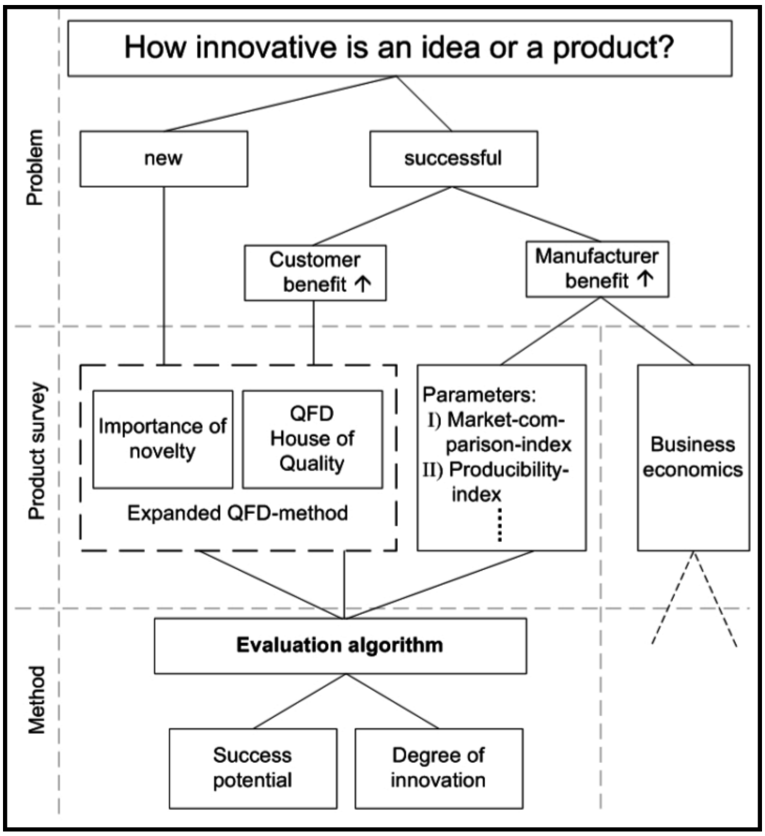

Figure 1. Evaluation Method flowchart for the evaluation of innovative ideas and products

Up to now, this new evaluation method only exists as a Microsoft Excel® based prototype, a standard Excel-file without any specially programmed interface. Nevertheless, the whole method is implemented, all input is done within the standard Excel worksheet. In the medium term, the method should become an entirely programmed application.

2.1 Parameters of the evaluation algorithm

Several parameters have to be specified and linked with each other by the evaluation algorithm. Table 1 shows the input parameters needed to allow a proper calculation of success potential and degree of innovation.

Table1. Input parameters of the evaluation algorithm

Name	Symbol	Quantity	Range
customer requirements (c.r.)	KA_s	s = 1, 2, …, m	
product requirements (p.r.)	PA_i	i = 1, 2, …, n	
weighting of c.r.	G_s	m	0, 1, …, 10
degree of fulfilment of the c.r.	EG_s	m	0, 1, …, 10
correlation factors	$KF_{i,s}$	n x m	0, 3, 6, 9
influencing variable on the product success	$EF_{e,i}$	e = I, II, …, V 5 x n	0, 1, …, 100
importance of novelty of c.r.	$p_{NB,s}$	m	0, 1, …, 10
importance of novelty of p.r.	$p_{NB,i}$	n	0, 1, …, 10

Apparently, by applying the method, the effort to specify all parameters rises analogous to QFD, with an increasing number of customer and product requirements, especially affecting the correlation factors. Considering the evaluation algorithm given in the next chapter, the number of parameters of the mathematical system for the success potential is

$$Z_{EP} = 2 \cdot m + m \cdot n + 5 \cdot n \tag{1}$$

whereas the number of parameters for the degree of innovation is

$$Z_{IG} = 3 \cdot m + m \cdot n + 6 \cdot n \tag{2}$$

For an evaluation with, i.e. 10 customer requirements and 15 product requirements, this leads to 245 variables for the success potential and 270 for the degree of innovation respectively. On this account, another task in improving the evaluation method is to reduce the effort when applying it without reducing the quality of the results. But this issue is not discussed in this paper.

2.2 Results of the evaluation algorithm

In order to determine the success potential and the degree of innovation, indicators must be identified by a mathematic link between the key variables from the QFD product assessment, the technical importance of the product requirements and the influencing variables on product success I to V. These indicators should reflect the degree of fulfilment of the customer requirements and the feasibility of the product requirements including all prerequisites and risks. The links are represented in five portfolios [1].

The average value of the five valuation factors (E_I … E_V) is identified as success potential. This specification now allows the definition of the term “success potential” on a mathematical basis:

$$E_P = \frac{p_I \cdot E_I + p_{II} \cdot E_{II} + p_{III} \cdot E_{III} + p_{IV} \cdot E_{IV} + p_V \cdot E_V}{p_I + p_{II} + p_{III} + p_{IV} + p_V} \tag{3}$$

E_P: Success potential
$p_I \ldots p_V$: Weighting factors
$E_I \ldots E_V$: Valuation factors of the influencing variables I to V

The degree of innovation is then calculated quasi in the same way as the success potential. As now only the “share of novelty” of the technical importance is used for calculation, the result obtained is the “share of novelty” of the success potential. This can also be called “novelty potential” or, even better, “degree of innovation”, since all innovative parameters are taken into consideration in this calculation:

$$I_G = \frac{q_I \cdot I_I + q_{II} \cdot I_{II} + q_{III} \cdot I_{III} + q_{IV} \cdot I_{IV} + q_V \cdot I_V}{q_I + q_{II} + q_{III} + q_{IV} + q_V} \tag{4}$$

I_G: Degree of innovation
$q_I \ldots q_V$: Weighting factors
$I_I \ldots I_V$: Valuation factors of the influencing variables I to V *with novelty*

3 DEFINITION OF THE TASK

The evaluation algorithm was tested and validated in five pilot projects. On the one hand, products already on the market and, on the other hand, product ideas from the development and design phase were chosen as test objects. Typical projects of the consumer and the investment goods industry were selected as pilot projects (see Table 2). The completed evaluations should show a spectrum of possible results in the innovation process.

Table 2. Results of pilot projects

Project	Unit	Company	Success potential	Degree of innovation
A	Cordless drill “Power Grip”	Metabo, Nürtingen	81,9 %	31,2 %
B	Snow blower	X	75,0 %	6,4 %
C	Modular multiphase low-cost electric drive	Y	81,0 %	38,3 %
D	Miniature translation stage	Festo, Esslingen	83,0 %	32,6 %
E	Hair styler C 20 S	Braun, Kronberg	85,2 %	36,6 %

Basically, the pilot tests showed that the evaluation is applicable already at an early stage of the innovation process, from the moment when concrete customer requirements are known. However, the obtained results were somewhat unexpected. Despite the range of different projects from different industry sectors, the resulting indices for the success potential as well as for the degree of innovation were very close together. The index for the success potential always reached almost similar high values, whereas the index for the degree of innovation levelled off at values below the expectations. Table 2 shows the evaluated pilot projects with their results [5].
Here the question arose whether this issue results from the evaluation method or its algorithm. Therefore, a sensitivity analysis of the evaluation method appeared to be essential to explore the behaviour of the method regarding the output indices depending on a change of the input parameters. The target of this sensitivity analysis was to reveal possible weak points and to develop an improved algorithm, if necessary.

4 SENSITIVITY ANALYSIS

The sensitivity analysis was carried out in two steps, especially focusing on the limits of the algorithm. The first step was an analytical approach, namely a mathematical analysis of the algorithm with the objective of getting an overall term for the algorithm, a function only depending on the input parameters. The second step was a numerical approach, which means the evaluation of the algorithm by changing the input parameters and a graphical visualization afterwards.

4.1 Analytical approach

In order to get an overall term for the algorithm which is a function of input parameters only, starting from the terms above, all variables were substituted step by step. Terms for both the success potential and the degree of innovation were regarded as results independent from the methods of weighting and averaging. However, these terms do not only depend on the input parameters. By diversification of the general terms, depending on the used averaging method different terms were received. Each of these terms is solely a function of the input parameters.

The original algorithm allows several kinds of averaging and weighting. However, the advanced analytical consideration has been applied as a first attempt for the common case of arithmetic averaging, but without weighting. The five pilot projects were also evaluated in this way.
The following considerations are done exemplarily for the algorithm of the success potential. Due to the definition of the degree of innovation as the share of novelty of the success potential (see Figure 1), the conclusions are also valid for the algorithm of the degree of innovation.
According to the nomenclature of parameters in Table 1, the original evaluation algorithm for the success potential (with arithmetic averaging and without weighting) is exemplarily given as follows:

$$E_P = \frac{5}{12} \cdot \frac{1}{n} \cdot \sum_{i=1}^{n} \frac{100 \cdot \sum_{s=1}^{m} G_s \cdot KF_{i,s}}{\max\left[\sum_{s=1}^{m} G_s \cdot KF_{i,s}\right]} + \frac{1}{12} \cdot \frac{1}{n} \cdot \sum_{i=1}^{n} \sum_{e=I}^{V} EF_{e,i} + \frac{2}{12} \cdot \frac{1}{m} \cdot \sum_{s=1}^{m} G_s \cdot EG_s \tag{5}$$

For the further considerations, the auxiliary variable “technical importance” TB_i (7) is introduced. For each product requirement, one value for the technical importance is calculated. The single summands for each technical importance are defined as the product of weighting factor and correlation factor of a corresponding pair of customer and product requirements:

$$TB_{i,s} = G_s \cdot KF_{i,s} \tag{6}$$

The technical importance for one product requirement is then defined as the standardized column total of all single summands:

$$TB_i = \sum_{s=1}^{m} TB_{i,s} \tag{7}$$

With the help of the equations (6) and (7) and in consequence of the fact that the algorithm (5) is a summation of three parts, the following basic conclusions can be derived:

1. The arithmetic average of the technical importance (TB_i) contributes to the success potential to an extent of 5/12.
2. The arithmetic average of the five influencing variables on the product success ($EF_{e,i}$) also contributes with 5/12 (1/12 each) to the success potential.
3. The arithmetic average of the product of weighting (G_s) and degree of fulfilment of the customer requirements (EG_s) finally contributes with 2/12 to the success potential.

This leads to the following conclusions:

4. As it is impossible for all weightings of customer requirements and all correlation factors to become zero at the same time, it is evident that the algorithm’s result (5) cannot be zero in any case.
5. In case that all customer requirements are not fulfilled as well as all influencing variables of the product success become zero, the success potential still takes the value of 5/12 of the average technical importance.
6. For the inverse case that all customer requirements are fulfilled completely and all influencing variables of the product success take the maximum value of 100, the success potential does not inevitably reach 100%, but is still depending on the average of the technical importance.

4.2 Numerical approach

Due to the huge amount of parameters in the algorithm’s function (see chapter 2.1) and in order to visualize the results, one parameter was selected at a time as control variable whereas the other parameters were kept constant. The same extent was assigned to each single value of the selected parameter, uniformly distributed within the allowed range of values.
Another problem of the analysis is that not all parameters are applicable as control variables. According to Table 1

- the degree of fulfilment of the customer requirements,
- the importance of novelty and
- the influencing variable on the product success

could be used as control variable.

On the other hand, parameters not suitable for a control variable are
- the weighting of the customer requirements and
- the correlation factors.

Despite the approach of reducing the variables to be visualized, the number of graphs is still very high, since there is not only one algorithm to be considered. Due to the diversification by averaging methods there are seven basic types and for each of them there is an algorithm for the success potential as well as for the degree of innovation. However, as examples, some of the results and graphs are shown below.

4.2.1 Fulfilment of the customer requirements as control variable

This parameter was selected as control variable according to the description above. The influencing variables on the product success are kept constant, but at different discrete values, which leads to a set of curves instead of one single graph. The other parameters are chosen according to Table 3.
As the parameters of the importance of novelty reach the maximum, the graphs for the success potential are identical to those of the degree of innovation, according to the definition of the degree of innovation as the share of novelty of the success potential.

Table 3. Set-up of parameters for Figure 2

Name	Symbol	Type	Value
weighting of c.r.	G_s	constant	10
degree of fulfilment of the c.r.	EG_s	control variable	0 … 10
correlation factors	$KF_{i,s}$	constant	9
influencing variable on the product success	$EF_{e,i}$	discrete values	100; 75; 50; 25; 0
importance of novelty of c.r.	$p_{NB,s}$	constant	10
importance of novelty of p.r.	$p_{NB,i}$	constant	10

The different discrete values of the influencing variables on the product success cause a parallel translation of the increasing straight line representing the success potential. The left boundary of the graph deserves closer attention. At this point, all values for the degree of fulfilment of the customer requirements are zero, the customer requirements are not fulfilled at all. A success potential of zero would be expected here. Anyhow, in that case, the value for the success potential is located between 41,7% and 83,3%, depending on the influencing variables on the product success.
Apart from the interpretation of what the value of more than 41 percent for the success potential represents in case no customer requirement is fulfilled, this behaviour of the algorithm leads to straight lines with a small upward gradient of only 1,67.
Furthermore, taking into consideration that in the five pilot projects the average degree of fulfilment of the customer requirements always took values between 7,0 and 8,43, the success potential in these projects could change within a range of only about 2,4 %.
Figure 2 shows the graph according to Table 3. For a better comparison, the graph for the new algorithm ($EP_{alternativ}$, see chapter 6) is already shown as well.

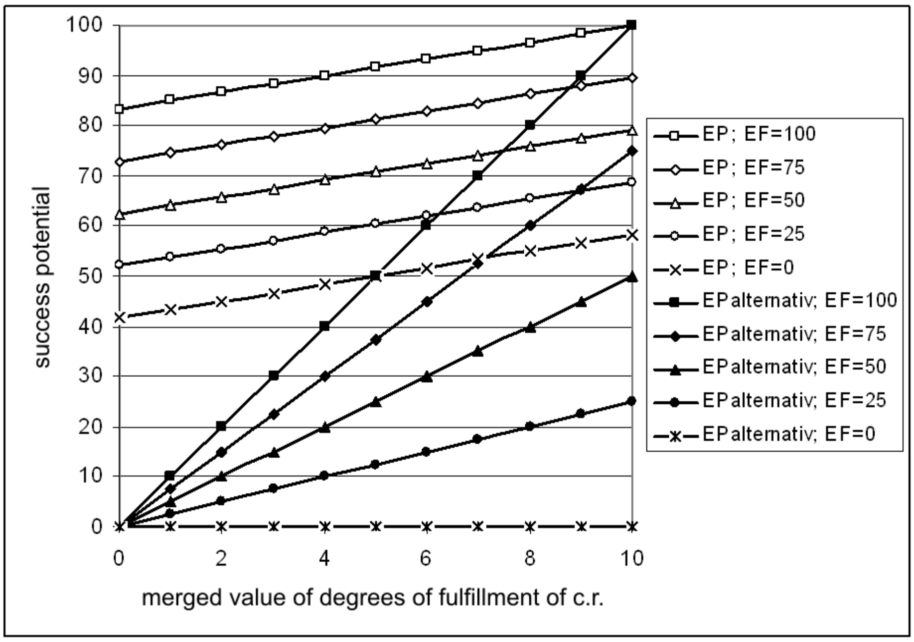

Figure 2. Graph of success potential with degree of fulfilment as control variable based on Table 3 [7]

4.2.2 Influencing variables on the product success as control variable

This graph especially has to be compared to the one mentioned above. The parameters here are nearly the same as before except the two parameters "degree of fulfilment of the c.r." and "influencing variables on the product success", which have changed their role. As the values for the importance of novelty are kept at their maximum, the graphs are also valid for the algorithm of the degree of innovation.

Table 4. Set-up of parameters for Figure 3

Name	Symbol	Type	Value
weighting of c.r.	G_s	constant	10
degree of fulfilment of the c.r.	EG_s	discrete values	10; 7,5; 5,0; 2,5; 0
correlation factors	$KF_{i,s}$	constant	9
influencing variable on the product success	$EF_{e,i}$	control variable	0 … 100
importance of novelty of c.r.	$p_{NB,s}$	constant	10
importance of novelty of p.r.	$p_{NB,i}$	constant	10

Here the discrete values for the degree of fulfilment of the customer requirements again cause a parallel translation of the graphs, yet to a lesser extent. The gradient is higher than in Figure 2, hence the algorithm is more sensitive to changes of the influencing variables on the product success than of the degree of fulfilment of the customer requirements.

Looking at the analytical approach (see chapter 3.1), this is in consequence of the algorithm's design. The term for the degree of fulfilment of the customer requirements contributes to an extent of 2/12 to the success potential, whereas the share of the influencing variables on the product success amounts to 5/12.

Again the left boundary of the graph is noticeable. If there is no extended manufacturer's benefit (all influencing variables are zero), the success potential takes a value between 41,7% and 58,3%. Also here the left-sided limit of the graph should be zero. In comparison, the graph for the new algorithm ($EP_{alternativ}$, see chapter 6) is shown as well.

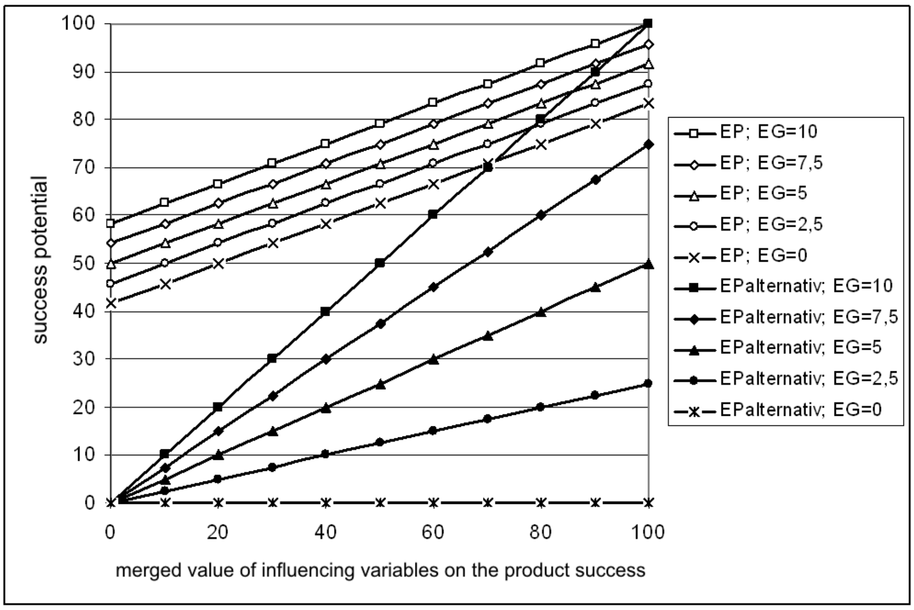

Figure 3. Graph of success potential with influencing variables on the product success as control variable based on Table 4 [7]

4.2.3 Examination of different constellations of arrangements of parameters

This examination makes allowance for the random distribution of parameters when evaluating a product. For this purpose, the graph is not plotted for a specific control variable, but for different constellations of values assigned to specific parameters.

The correlation factors are selected in a way that the technical importance appears in a linear equal distribution. Furthermore, the influencing variables on the product success are distributed in the same way, viz. all values in the range from zero to 100 appear evenly distributed. The average of both the technical importance and the influencing variables on the product success remain at a value of 50 for every constellation.

Table 5. Assortment of parameters for Figure 5

Name	Symbol	Type	Value
weighting of c.r.	G_s	constant	10
degree of fulfilment of the c.r.	EG_s	constant	10
correlation factors	$KF_{i,s}$	specific constellation	equal linear distribution
influencing variable on the product success	$EF_{e,i}$	specific constellation	equal linear distribution
importance of novelty of c.r.	$p_{NB,s}$	constant	10
importance of novelty of p.r.	$p_{NB,i}$	constant	10

In the first constellation the highest value of the technical importance meets the highest value of the influencing variables, the second highest meets the second highest etc. In the following constellations, the order of the influencing variables shifts one position in each case. In this way, new constellations are generated as long as the sequence of the influencing variables has reversed completely and the highest value of the technical importance meets the lowest value of the influencing variables (see Figure 4). All other parameters are held at their maximum (see Table 5).

A hypothetical product with 16 product requirements was supposed in order to determinate the success potential. The plotted graph is independent of the number of product requirements. Any other number of product requirements would result in the same graph, but with different gradation (Figure 5).

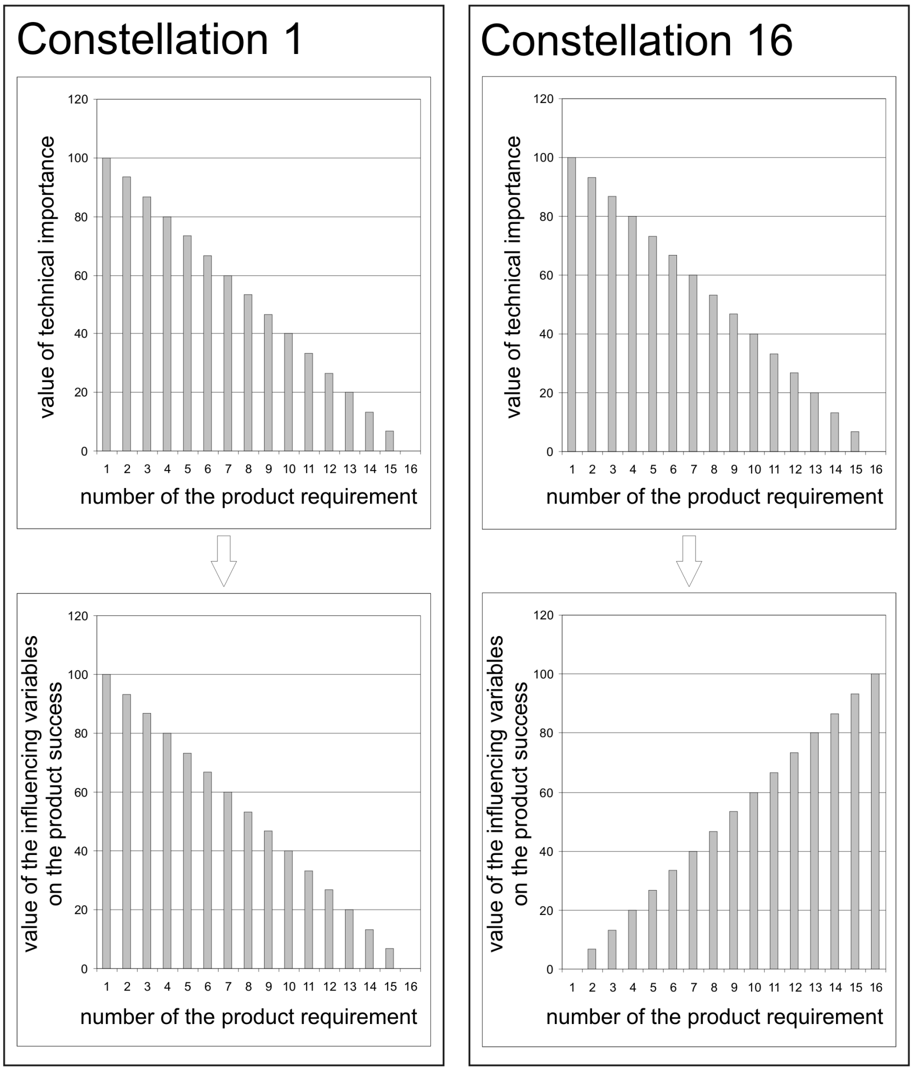

Figure 4. Extrema of constellations for evenly spread parameters [7]

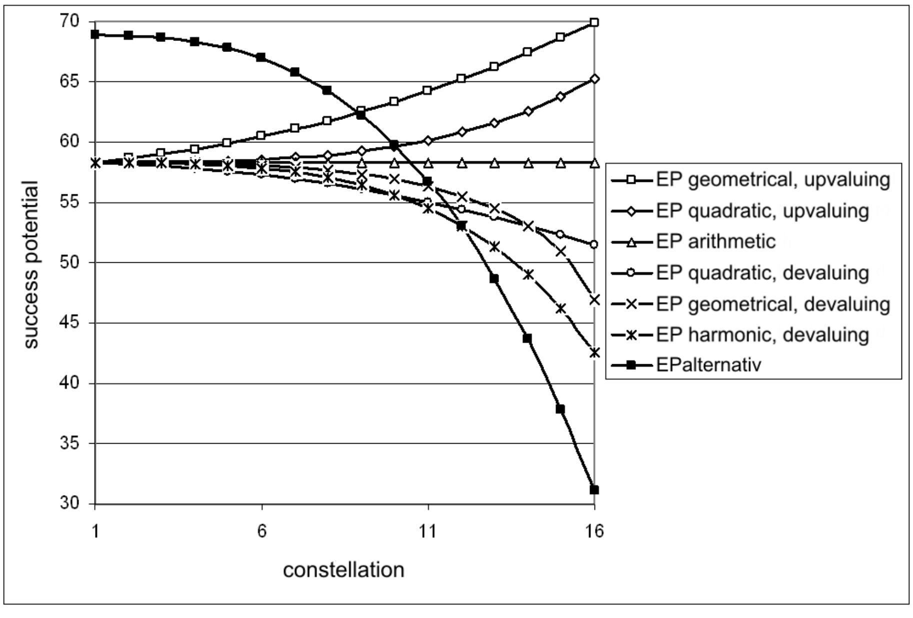

Figure 5. Graph for the success potential for several averaging methods with successive constellations according to Table 5 and Figure 4 [7]

This graph shows the very different character of the particular methods of averaging. In case important product requirements correlate with low influencing variables (having a minor manufacturer's benefit), the upvaluing methods of averaging misleadingly boost the success potential.
For arithmetic averaging, the algorithm is only affected by the means of both technical importance and influencing variables on the product success. As both averages do not change for all constellations, the graph for arithmetic averaging is a horizontal straight line, which means that it would be irrelevant if important product requirements featured either a major or minor benefit to the manufacturer.
When important product requirements have a lesser impact on the manufacturer's benefit, this is taken into account correctly by the devaluing methods of averaging. The graph for the new algorithm ($EP_{alternativ}$, see chapter 6) is also shown in Figure 5.

5 RESULTS OF THE SENSITIVITY ANALYSIS

The analysis carried out and presented in extracts in the previous chapter revealed a couple of weak points which lead to some unwanted characteristics of the evaluation method and its results. The main issues are described below.

1. The weighting parameters of the customer requirements and technical importance, derived from the QFD, are not used as items relative to each other as it is postulated in the QFD [8]. Their absolute extent still affects the success potential and the degree of innovation although it has no informational value for this purpose.
2. The mathematical link between technical importance and influencing variables on the product success is done by average determination. It is difficult to recognize the significance of the resulting auxiliary variable "influence valuation factor" (see equation (3)). Here the average of one relative and one absolute item is determined. In consequence, this way of linking is reflected in a minor sensitivity of the algorithm. For the practical relevant range of values the algorithm shows only a slight upward gradient of the graph.
3. Depending on the averaging method, the graph could show a wrong trend (see Figure 5). When using an upvaluing averaging method, the success potential could be higher for important product requirements with a minor manufacturer's benefit than for important product requirements with a major manufacturer's benefit. This effect is not explainable when evaluating a real product.
4. Another weak point is the fact that the values for the degree of fulfilment of the customer requirements are taken into account by simply adding them up. Thus the graph cannot comply with expected limits for the success potential. On the one hand it would be expected that a product not fulfilling any customer requirement or without any benefit to the manufacturer would not have any success potential. Basically this is not fulfilled in any case. On the other hand, it is evident that a product, totally fulfilling all customer requirements and, additionally, with a maximum manufacturer's benefit, achieves a maximum success potential of 100 %. This is not guaranteed either.

6 NEW EVALUATION ALGORITHM

In order to improve the algorithm and eliminate weak points discovered before, a new design approach for the algorithm was developed.

6.1 Requirements for the new algorithm

As an extract of all requirements for the new algorithm, based on the sensitivity analysis, the most important requirements are:

- including all parameters already established and using them exclusively,
- abstaining from auxiliary variables deteriorating the transparency and plausibility,
- using the full range of values from 0 % to 100 % for the indices of both success potential and degree of innovation,
- giving an index of 0 % as a result for both the success potential and the degree of innovation, if no customer requirement is fulfilled,
- giving an index of 0 % as a result for both the success potential and the degree of innovation, if there is no manufacturer's benefit and all influencing variables on the product success take the

value of zero,

- giving an index of 100 % as a result for the success potential, if all customer requirements are fulfilled completely and all influencing variables on the product success reach their maximum too,
- giving an index of 100 % as a result for the degree of innovation, if additionally all values for the importance of novelty reach their maximum,
- giving an index of 0 % as a result for the degree of innovation, independent of the success potential, if all values for the importance of novelty are zero.

6.2 The new algorithms

The approach for the two algorithms follows the requirements which are the results of the detailed analysis carried out. Without going into details, the new algorithms are introduced and their behaviour is compared to the original algorithms.
As a new approach for the algorithm for the success potential, the following term was developed:

$$E_{P,alternativ} = \sum_{i=1}^{n} \left[\frac{\sum_{s=1}^{m} G_s \cdot KF_{i,s} \cdot \frac{EG_s}{10}}{\sum_{s=1}^{m} \sum_{i=1}^{n} G_s \cdot KF_{i,s}} \cdot \frac{\sum_{e=I}^{V} EF_{e,i}}{5} \right] \tag{8}$$

According to (8) the new algorithm for the degree of innovation is:

$$I_{G,alternativ} = \sum_{i=1}^{n} \left[\frac{\sum_{s=1}^{m} \left[G_s \cdot KF_{i,s} \cdot \frac{EG_s}{10} \cdot \left(\frac{\frac{p_{NB,s}}{10} \cdot e^{\frac{p_{NB,s}}{10}} + \frac{p_{NB,i}}{10} \cdot e^{\frac{p_{NB,i}}{10}}}{2 \cdot e} \right) \right]}{\sum_{s=1}^{m} \sum_{i=1}^{n} G_s \cdot KF_{i,s}} \cdot \frac{\sum_{e=I}^{V} EF_{e,i}}{5} \right] \tag{9}$$

6.3 Comparison of original and new algorithm

Using the examples of the numerical approach of the sensitivity analysis (see chapter 4.2), the new algorithm is compared to the original one.
With the parameter fulfilment of customer requirements as control variable, the original algorithm brought up some inadequate results. The new algorithm improves the behaviour of the evaluation method according to the requirements postulated above (see chapter 6.1). As shown in Figure 2, the new algorithm provides different gradients for different values of the influencing variables on the product success. Furthermore, if no customer requirement is fulfilled, the success potential becomes zero. Additionally, the new algorithm now allows both the index for the success potential and the index for the degree of innovation to take a value between 0 % and 100 %.
These conclusions also hold true for the graph with the influencing variables on the product success (see Figure 3). In fact, the graphs for the new algorithm are identical in both cases. This is due to the fact that the discrete values for the influencing variables as well as the values for the degrees of fulfilment are handled by the new algorithm in the same way.
Finally, comparing the new and old algorithm in Figure 5, the new algorithm shows an appropriate behaviour regarding the different constellations of technical importance and the influencing variables on the product success described above. Now, in terms of the success potential, it is honoured when important product requirements also contribute to the manufacturer's benefit to a major extent.

7 CONCLUSION

The presented evaluation method to determine the success potential and the degree of innovation has been tested in five pilot projects and delivered some unexpected results. Therefore, a sensitivity analysis of the method's algorithm had been carried out, revealing a couple of inconsistencies. With the new approach for the algorithms of the success potential and the degree of innovation, the weak points of the original algorithms have been eliminated.
A great advantage of the new algorithm is that it solves the problems without affecting the basic character of the original method, which also was a requirement for its development.
In certain cases, the problem of wrong trends is fixed by the new algorithm and the improved evaluation method shows a more realistic behaviour in practice.
In order to verify the reliability of the new algorithm and the improved evaluation method, application and testing of different product classes are necessary. First tests in industry projects have been started recently, however, results are not yet available.
The next step to improve the evaluation method can now aim at the usability. When applying the method, the effort to specify all parameters rises with an increasing number of customer and product requirements. Hence a possible objective could be to reduce the effort of specifying the input parameters without any impairment of the method's accuracy and reliability.

REFERENCES

[1] Binz, H.; Reichle, M. Evaluation Method to Determine the Success Potential and the Degree of Innovation of Technical Product Ideas and Products. In *15th International Conference on Engineering Design, ICED '05*, Melbourne, 2005, pp. 55 – 56.
[2] Böhm, E. Ein Instrument zur Unterstützung von Forschungs- und Entwicklungsmanagement in Industrieunternehmen, 1996 (Universität Karlsruhe, Fakultät Wirtschaftswissenschaften)
[3] Brandenburg, F. Methodik zur Planung technologischer Produktinnovationen, 2001 (RWTH Aachen, Fachbereich Maschinenwesen)
[4] Hargadon, A.; Sutton, R. Building an Innovation Factory. In *Harvard Business Review on Innovation*, 2001 (Harvard Business School Publ. Corp.).
[5] Reichle, M. Bewertungsverfahren zur Bestimmung des Erfolgspotentials und des Innovationsgrades von Produkten und Produktideen, 2006 (Universität Stuttgart, Institut fuer Konstruktionstechnik und Technisches Design). http://elib.uni-stuttgart.de/opus/volltexte/2006/2772/pdf/Diss_Online_Dokumentation.pdf
[6] Rohe, C. Werkzeuge fuer das Innovationsmanagement, 1999 (F.A.Z.-Buch)
[7] Overkamp, J. Sensitivitätsanalyse und Entwicklung eines Algorithmus eines Bewertungsverfahrens zur Innovationsgradmessung, 2006 (Universität Stuttgart, Institut fuer Konstruktionstechnik und Technisches Design).
[8] Pfeifer, T. Praxisbuch Qualitaetsmanagement, 2001 (Carl Hanser Verlag).
[9] Warnecke, G., Rauch, C., Puhl, H. Technische Innovation im Spannungsfeld von Systemkomplexität und Gestaltungskompetenz. In *Innovative Produktionstechnik, Festschrift zum 70. Geburtstag von G. Spur*, 1999 (Carl Hanser Verlag)

Dipl.-Ing. Thomas Weller
Institute for Engineering Design and Industrial Design
Universität Stuttgart
Pfaffenwaldring 9
70569 Stuttgart
Germany
+49 (0)711 685 66054
thomas.weller@iktd.uni-stuttgart.de
http://www.iktd.uni-stuttgart.de