MAHLO GmbH & Co. KG

THE VALUE-ANALYTICAL DEVELOPMENT OF A GENERATION OF TEXTILE MACHINES – THE IMPORTANCE OF HAVING A METHODOLOGICAL APPROACH, EVEN DURING THE IMPLEMENTATION PHASE OF A VALUE-MANAGEMENT PROJECT

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1. Summary

MAHLO GmbH & Co. KG is a medium-sized company headquartered in Saal (Donau) in Lower Bavaria, Germany. With approximately 250 employees, MAHLO has developed, produced and marketed straightening, processing and quality-control systems for web- or sheet-form media, such as textiles and nonwovens, for a wide range of customer requirements. The company has been active for 70 years now. MAHLO's management decided to use value analysis for re-engineering the RVMC line of straightening systems in order to systematically ensure the product's future viability and competitiveness.

Alongside aiming to significantly reduce production costs, an important project goal was to develop a new generation of machines whose properties will correspond to customer requirements over the next ten years. In the process, the interrelationships of the assemblies being used throughout the whole MAHLO spectrum of products had to be taken into account. The project scope had to also account for overcoming the substantial expenses associated with implementing the new product line. The implementation phase encompassed the following steps:

- Implementing technical measures identified in the design phase while taking into account both target cost and customer requirements.
- Managing projects and capacity, scheduling
- Introducing an "interim generation" in order to achieve initial cost reductions and establish new technologies in the market
- Managing the goods-in and goods-out processes for the products in the line

Both in the design and implementation phases, the approach taken followed value-analysis methodology:

- Working in interdisciplinary teams with periodic support from specialists
- Collecting and analyzing customer-relevant requirements
- Compiling and evaluating information on the competition
- Surveying specialists
- Performing functional and functional cost analyses, in part to prioritize idea generation (cost-driver functions)
- Searching for ideas in the functions
- Evaluating ideas and converting them into measures
- Combining measures with new designs accepted by the customer
- Implementing measures to support the project, to the extent possible

In the design phase nearly 250 individual measures were developed. Of these measures, two designs for a multi-stage implementation of the new machine generation were developed and proposed for implementation.

Within the framework of overall project management, a milestone plan was put in place. This also supports the actions necessary for implementing this new machine generation. Particular focus was placed on testing new technologies in field tests for selected customers. In introducing the new machine generation, all other corporate functions were systematically integrated into a special implementation plan.

Management evaluated the project very positively, not only with respect to cost savings but also in relation to how an interdisciplinary project would affect the corporate culture. Here, too, the project work resulted in a building block for safeguarding the company's future success. It will certainly not be the last of its kind at MAHLO.

2. Presentation of the Company

MAHLO GmbH & Co. KG is a medium-sized company headquartered in Saal (Donau) in Lower Bavaria, Germany. It is one of the world's leading manufacturers of measurement, control and automation systems for the textile and finishing industries as well as the coating, film and paper sector.

A company with a long tradition, it was founded in 1945 and now employs approximately 250 employees. Research and development activities, as well as production and assembly of all MAHLO machines, are located at the headquarters in Saal. Numerous sales and service branches throughout the world ensure optimal local support for customers in target markets.

MAHLO produces high-tech machines that optimally integrate physical measuring principles, mechanical drive technology and proprietary control/regulation technology. MAHLO employees, who are both experienced and excellently trained, create maximum customer benefit in all applications by optimally combining these three elements.

The main application area of MAHLO machines remains the textile industry. But other industrial sectors, such as nonwoven, paper and film, also benefit increasingly from the capabilities of MAHLO products. In order to satisfy all customer needs, MAHLO maintains a complex product line with a high degree of variability and adaptability for given customer applications.

MAHLO is facing increasing competitive pressure. In the main textile market, more and more competitors from lower-income countries are operating alongside western European manufacturers. In the new application areas, MAHLO still has to establish itself against competitors in the market that are already well known.

MAHLO's management recognized this development early and has planned and executed corresponding countermeasures. One of these measures is reducing the production costs of the main revenue generator, the Orthopac modular straightening and process control system. In a focused value analysis project with external support, the Orthopac straightening and process control system was re-engineered and converted into a new generation of machines.

An Orthopac straightening system detects distortions in woven and knitted fabrics or tufted carpets and precisely straightens even the most complicated textiles at a high fabric speed. Numerous Orthopac variants can be combined in order to adapt the process to specific individual requirements.

3. Project Tasks and Goals

The management specified and formulated the scope of the project as follows: re-engineering the Orthopac modular straightening and process control system, based on a value analysis to drastically reduce production costs.

The following goals were set for the value analysis project:

- Reducing production costs (measured representatively) by 20% of current production costs
- Developing new functions to differentiate the company from the competition over the long term
- Exploring options to minimize cycle time (to increase potential revenue)
- If possible and sensible, standardizing affected components beyond the product line
- Developing quick wins to facilitate the quickest possible implementation and therefore the quickest effect on profits

4. The Project Team: The Success Factor in the Value Analysis Project

A project team comprised of specialists from MAHLO and external support was formed to carry out the project. The project team was set up to be interdisciplinary in order to manage the project's complexity and enable a holistic approach.

In the selection of team members, the technical and personal suitability of the team members was taken into account. The disciplines represented in the core team were as follows:

- Marketing
- Work preparation
- Assembly
- Operations: oroduction, purchasing, logistics, materials management
- Hardware development
- Software development
- Design

The core team consisted of nine people plus external moderation and was available for the entire project term. In certain phases, support from additional disciplines, such as application technology and service, was required. Due to the structures of medium-sized companies, the short decision paths and the outstanding project support from management, it was always possible to act quickly and expediently in the best interests of the project.

5. Structured Approach Through Value Analysis

The project approach was oriented toward value-management procedural steps in compliance with VDI 2800/EN12973. The value-analysis working plan served as the guide to the project. It also helped provide a clear orientation and direction and prevent that important content be forgotten.

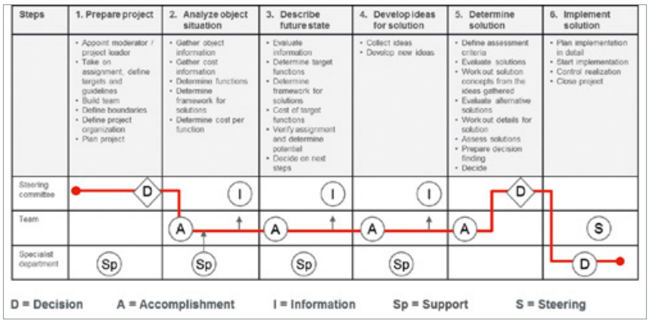

Figure 1: Value analysis working plan based on VDI 2800, simplified here in six steps

For a better overview and transparency, the complex project was divided organizationally into three phases, whereby the project term from analysis through introduction of the new generation of machines spanned a period of approximately 2.5 years. At the end of each phase, the project status was coordinated with, and presented to, the client.

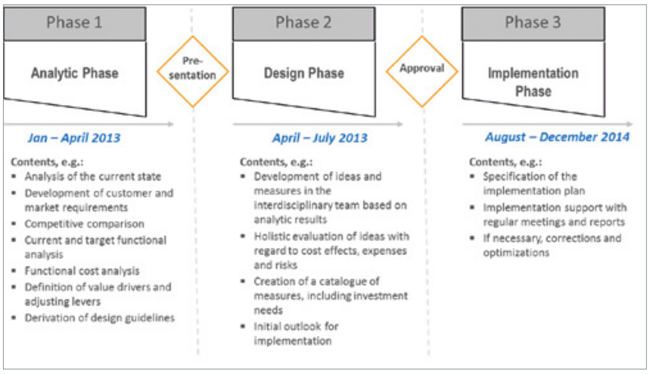

Figure 2: Project phases

The core team managed the content-related design of the project. The team met regularly during the project term to monitor, plan and ensure the progress of the project.

6. Analytic Phase

6.1 Selection of a Reference Product

For further work in the project, it was necessary to select a reference product from the complex product structure of the Orthopac straightening and process control system. The product would need to simplify further project work, while being representative enough of the entire product family. Relative to this reference product, the RVMC straightening machine, all the analyses and cost considerations required by the project were undertaken, while later in the project the potential of ideas and cost-reduction measures was evaluated.

6.2 Development of a Customer Perspective

At the beginning of the project, the team had to develop a customer- and market-oriented perspective. They had to understand who the customers are and what they need from a straightening machine. Based on QFD methodology, the team developed and weighed the criteria by which the customer evaluates the product and makes a purchase decision.

No.	Customer requirements	Weighting 1 = unimportant 10 = very important
1	Scanning quality	10
2	User-friendly, intuitive operation	8
3	Low maintenance	3
4	Clear distortion visualization, design, look & feel	7
5	Good service	9
6	High-quality straightening/low residual distortion tolerances	10
7	Remote diagnostics	1
8	High accessibility	8
9	Compact design	4
10	High fabric speed	2
11	Low fabric content	3
12	Distortion/linear expansion/gentle treatment of fabric	8
13	Easy to maintain/easy to repair	2
14	Modularity/retrofitting capability	6
15	Easy integration/interfaces/logging	5
16	Durability	7
17	Short setup times	1
18	Visual impression	5

Figure 3: Purchase-decision criteria for the RVMC straightening machine and their weighting

In order to work out the purchase-decision criteria, input from in-house "customer experts" was particularly important. They are typically employees from sales, service and application technology who stand in direct contact with customers at various levels.

6.3 Determining the Current Market Position

In order to obtain a comprehensive market perspective and determine one's own market position, it is essential to consider the competition's products.

In comparing competitive products it is not a matter of copying someone else's ideas, but rather to evaluate objectively one's own product and the competition based on the prescribed criteria. This makes it possible to position the product in the market environment.

Criteria		Competitors						
Competitor Analysis		Importance	Mahlo RVMC-12	Competitor A	Competitor B	Competitor C	Competitor D	Competitor E
Scanning quality		10	30	30	20	20	20	10
User-friendly, intuitive operation		8	16	16	8	16	16	16
Low maintenance		3	6	6	6	6	6	6
Clear distortion visualization, design, look & feel		7	21	14	7	14	7	14
Good service		9	27	18	18	18	27	9
High-quality straightening/low residual distortion tolerances		10	20	20	20	20	20	20
Remote diagnostics		1	1	1	1	1	0	0
High accessibility		8	24	16	16	16	16	8
Compact design		4	12	8	4	8	8	8
High fabric speed		2	6	6	6	6	6	6
Low fabric content		3	9	6	6	6	6	6
Distortion/linear expansion/gentle treatment of fabric		8	24	16	16	16	16	8
Easy to maintain/easy to repair		2	4	2	2	2	2	2
Modularity/retrofitting capability		6	18	12	12	18	12	6
Easy integration/interfaces/logging		5	10	10	10	10	10	10
Durability		7	21	21	21	21	21	21
Short setup times		1	2	2	2	2	2	2
Visual impression		5	10	10	5	10	5	5
Total Customer Benefit			261	214	180	210	200	157

Figure 4: Competitive comparison

The evaluation of the customer comparison indicates the total customer benefit for each competitor (=sum of the degree of fulfillment for all defined criteria). Together with the information gained and additional details, e.g., about market price and market share, the following customer benefit price portfolio was created.

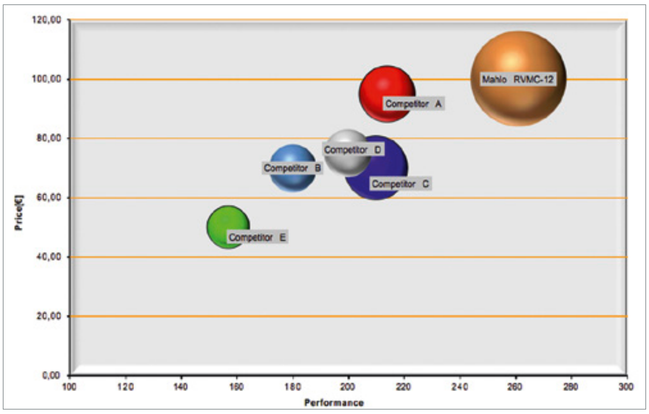

Figure 5: Customer benefit price portfolio

This chart shows the market positioning of MAHLO and its competitors in the area of straightening machines (CURRENT product):

- MAHLO is the market leader and offers the greatest benefits to the customer in the market.
- Evidently, there are also customers for whom less customer benefit is sufficient and who would like to pay a correspondingly lower price for it.

These insights essentially confirm the motivation and rationale for this project. Competitors are pushing into the market with machines that are being offered at a much lower price point but that satisfy customer requirements only minimally. MAHLO must anticipate the possibility of lower sales prices. In order to compensate and to maintain the margin, it is necessary to reduce production costs. In the process, the higher benefits to the customer, compared to the competition, may be questioned.

6.4 Functional Analysis

Functional analysis is an important step in, and one of the most essential characteristics of, a value analysis project. In functional analysis, a distinction is made between a subjective solution and an objective function. The functions (=the effects) of a product are described as a noun and verb and visualized in a suitable model (e.g., a function tree).

The goal of functional analysis is to change the way team members think about and look at things so that they can come up with a wider range of innovative solutions. Functional analysis systematically disrupts thinking in terms of existing solutions and creates, so to speak, a new field of vision.

First, the core team gathered the functions of the straightening machine and then structured them together into a function tree. Even in this early step, initial ideas for improvements were recognized and stored in an ideas pool for a subsequent project phase.

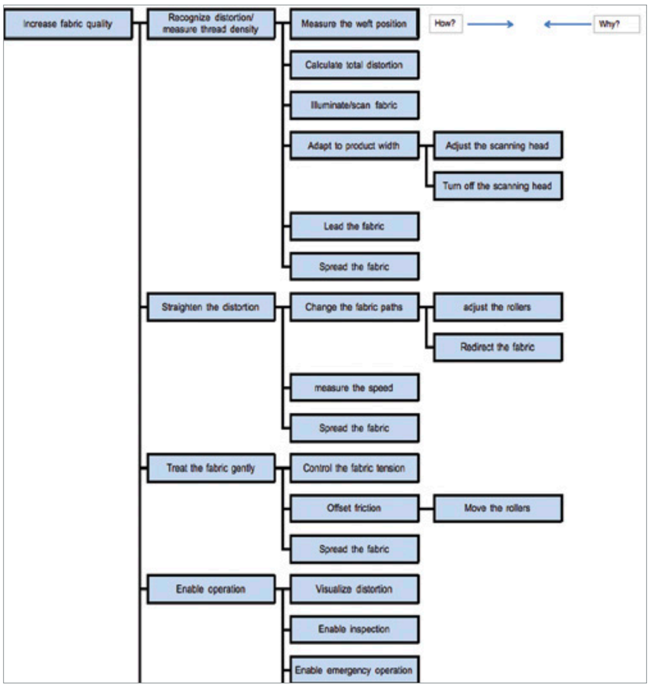

Figure 6: CURRENT product function tree (excerpt)

After the functional analysis based on what was seen in the rearview mirror (=CURRENT product), the core team looked ahead and determined the future functions of the straightening machine (=TARGET product). They were decided upon by taking into account customer requirements and using all degrees of freedom and then similarly structured in a function tree.

In the process, the main functions were mostly confirmed. Only those functions that were recognized as unnecessary were removed. For example, in the TARGET product, the function “adjust the scanning head” is left out because the function “adapt to product width” is sufficient and permits sufficient degrees of freedom for a new solution.

6.5 Functional Cost Analysis

Next, a functional cost analysis for the CURRENT and TARGET products was conducted in order to provide details for the insights from the functional analysis and to work out the cost drivers from the functional view.

For the CURRENT functions, actual production costs of the straightening machine were allocated to the functions using a function-cost matrix. For this, the total production costs of the reference product were set out at the corresponding level of detail. The costs of the individual components/assemblies were allocated according to the respective share of the corresponding function. For the sake of simplicity, the functional cost analysis was limited to functions at the first subfunction level in the function tree.

In order to determine the TARGET function costs, the following approach was taken: The purchase-decision criteria selected at the beginning of the project were examined in a matrix with the TARGET functions for their mutual influence. As a result, the higher value functions from the customer’s perspective, in other words those for which the customer would also spend more money, received a higher evaluation.

The results of the functional cost analysis were presented in a function cost diagram:

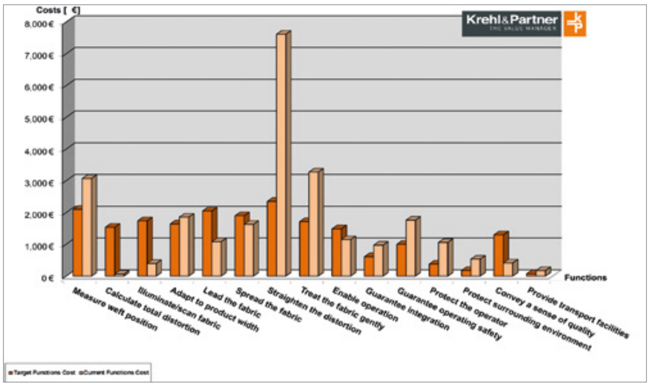

Figure 7: Functional cost diagram (TARGET/CURRENT)

From the TARGET/CURRENT distribution of functional costs, the following insights could be gained for the project:

1. The highest costs are found in the functions “recognize thread distortion/measure thread density,” “straighten the distortion” and “treat the fabric gently.” Consequently, the greatest potential can be discovered in these functions.

2. The high costs in the CURRENT product in the functions straighten the distortion and treat the fabric gently are not viewed as highly from the customer‘s perspective. Therefore, in the solutions to these functions, particular emphasis should be placed on cost reduction.

3. The costs of the function recognize thread distortion/ measure thread density are viewed more highly than the CURRENT costs indicate. The current solution of the function is already good. Potentially, an additional increase in quality can be achieved through suitable measures.

7. Design Phase

7.1 Creativity and the Search for Ideas

After a few approaches to cost reduction were worked out in the detailed analysis phase, the next step involved the systematic search for, and identification of, additional ideas. In this creative phase, a strict distinction was made been searching for ideas and evaluating ideas. In this step, team moderation played an important role since in practice the creative process is often disrupted when the steps of searching for ideas and evaluating ideas intermingle. Through the targeted use of moderation techniques and diverse approaches to uncovering ideas, in a short period of time, more than 250 ideas and measures for cost reduction were developed.

The creativity-promoting approaches and successfully applied methods of discovering ideas were as follows:

- Drawing insights from functional analysis
- Search for ideas in a manner structured according to function
- Analyzing components and assemblies using 3D CAD models
- Integrating suppliers for key components
- Brainstorming, brainwriting
- Visiting and analyzing straightening machine assembly on location multiple times
- Searching for ideas using functional models

7.2 Evaluating ideas

Overall, in this phase the team developed more than 250 ideas and measures to reduce costs and/or to improve functions. Initially, these ideas were available only as ideas described in written form. In the next step, the core term evaluated them using a multistage evaluation process. The applied methodology took the approach of going from global to the detailed and encompassed the following steps:

1. A global evaluation of all discovered ideas. Initially a rough and quick evaluation was made whether this idea could or could not achieve its objective. The purpose of this step was to scale back the list of ideas to worthwhile ones. With the worthwhile ideas, another distinction was made between detail-oriented ideas (only changing a detail in the machine) and a conceptual idea (carrying out major changes to the machine). During this process, it was possible to change the rough evaluation status of an idea at a later time in case new information became available.

2. Detailed evaluation of the worthwhile ideas: In the second step, a refined evaluation of the ideas was carried out, regarding potential costs and investments (e.g., for plastic molding tools). This step was more expensive because various design work, computations, calculations, supplier inquiries and additional detailed work were necessary.

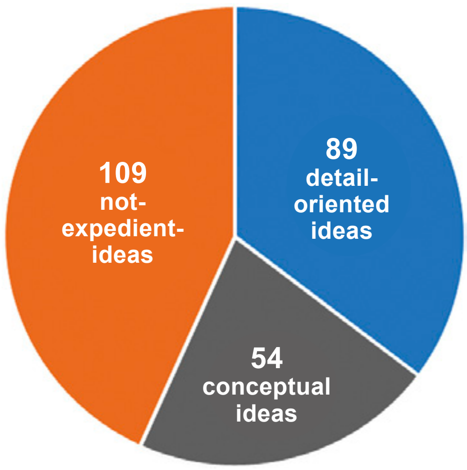

Figure 8: Distribution of ideas after multistage evaluation

7.3 Design Formation by Combining Ideas

Until this step, each of the ideas and measures was evaluated separately. Possible exclusion criteria and/or dependencies of ideas were not considered until this point. Only during design formation was it necessary to develop various scenarios by combining ideas. Taking this approach, the project team formed three designs with various objectives:

Maximal Design
All ideas flowed into this design that were compatible with each other and each of which offered the greatest potential. The market acceptance of measures was not primarily considered here. Instead, a progressive approach toward cost reduction was pursued.

Design 1 – Standard Straightening Machine:
All ideas flowed into this design that were compatible with each other and offered the greatest potential. The project team had to assume that all current MAHLO customers would accept the measures taken in this design.

Design 2 – Low-Cost Straightening Machine:
Here all ideas were activated that could be combined with each other and offered the greatest potential. Ideas in this design were selected based on a customer with lesser requirements.

7.4 Potential Savings With the Designs

Next the potential savings of the developed designs were compiled and added up:

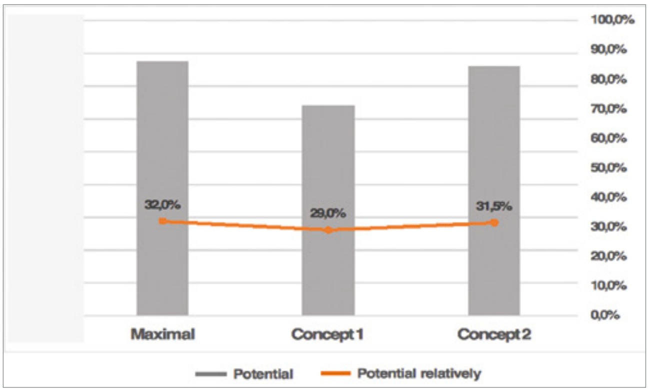

Figure 9: Potential savings with the designs

As expected, the greatest savings were achieved with the maximal design. Since, in the assessment of the project team, this design did not represent an acceptable solution for the market, it was rejected and not pursued further. The goal of forming this design was merely to represent the theoretically maximum savings without taking into account feasibility and market acceptance.

It was interesting that with the second design (low-cost machine), savings were achieved that were close to those with the maximal design. However, the low-cost version would serve only the lower market segment and lead to a two-product strategy at MAHLO. For this, a clear differentiation in form and appearance from the standard version (design 1) would be necessary. As a result of further discussions with the project team and the management, this step was not taken and the second design (low-cost machine) in this project was not further pursued.

In accordance with the scope of work, the focus was on the first design (standard straightening machine), which through value-analytical re-engineering could still lead to significant savings of 30%. In the opinion of the project team, MAHLO's main market and main customers until now would accept all solutions. Therefore, market acceptance would exist.

8. Implementation Phase

8.1 Design Presentation and Approval

The results of the design phase reached until this point and the designs along with the associated potential savings were presented to management. Management welcomed and approved the option proposed by the project team. In other words,

- the maximal design was not implemented.
- Design 2 will not be further pursued in this project.
- Design 1 (standard straightening machine) will be implemented.

Due to the expected complexity of the implementation phase and the necessary networking in the company, management has decided to continue the interdisciplinary teamwork that has been successful so far in this important project phase as well.

8.2 Formation of Work Packages

Next for design 1 (standard straightening machine), various work packages were formed from the numerous individual measures. For this, it was initially necessary to further specify the measures taken in the design, taking into account implementation-relevant criteria, such as the following:

- Implementation expense [h]
- Risks
- Dependencies on other ideas/measures
- Investments
- Inventories/framework agreements

Next the individual measures were consolidated into sensible work packages. The criteria applied for forming the work packages were as follows:

- Thematic cohesiveness: All ideas on the same topic/ on the same assembly in one package
- Work package size: Consideration of a sensible and manageable size for the work package
- Time-related feasibility: Distinction between "quick wins" and "medium-term implementation"
- Economic viability test: Plausibility check for the economic viability of measures

Through the compilation of work packages, an important distinction for further implementation emerged between ASAP packages (as soon as possible, quick wins) and work packages to be implemented over the medium term (generation 15 packages = machine generation 15).

As a result, an essential objective of the project, the identification of quick wins, was achieved. Fortunately, approximately 73% of the total potential of this design could be leveraged through the ASAP work packages.

Paket	Quick Wins		Generation 15	
	Potenzial des Paketes in [€]	Umsetzungsaufwand unter Berücksichtigung von Synergieeffekten in [h]	Potenzial des Paketes in [€]	Umsetzungsaufwand unter Berücksichtigung von Synergieeffekten in [h]
ABS	[illegible]	175		
Autark I	[illegible]	383		
Autark II			[illegible]	120
BSE I	[illegible]	289		
BSE II			[illegible]	150
Grundaufbau			[illegible]	360
Hydraulik			[illegible]	160
Netzteil	[illegible]	300		
Scheinwerfer	[illegible]	100		
Steuerung			[illegible]	3484
Tastkopf I	[illegible]	412		
Tastkopf II			[illegible]	180
Tastkopfbrücke I	[illegible]	130		
Tastkopfbrücke II			[illegible]	292
Traversensatz	[illegible]	100		
WSR I	[illegible]	68		
WSR II			[illegible]	386
Summe	[illegible]	1.957	[illegible]	5.132

Figure 10: Work packages (quick wins and implementable over the medium term)

8.3 Tools Used in Implementation

The project team developed various tools for managing the implementation phase. Front and center was the general plan, which displayed a complete overview of all work packages and their status.

General plan:

- Determine the main individuals responsible and the processing teams for package implementation
- Represent and assesses implementation dependencies between the work packages
- Schedule the beginning and end of work taking into account implementation expense
- Schedule the deadline for implementation depending on inventories and master agreements (=the work package taking effect)
- Determine the processing sequence depending on the ratio of potential to implementation expense
- Control hours expended

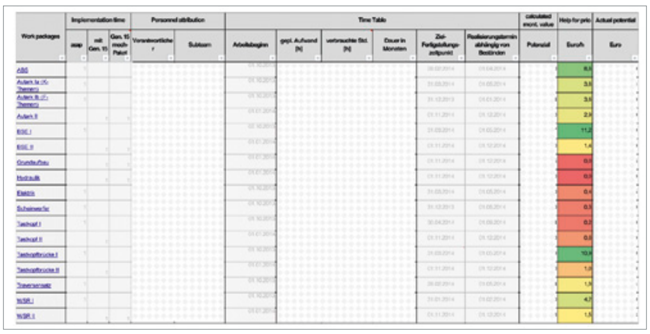

Figure 11: General plan

Particularly worth mentioning in this context may be the prioritization assistance worked out for determining the processing sequence for work packages (see figure 11, column prio-aid). For this, a ratio was established relating the potential of the work package to the respective implementation expense. This quotient indicates the potential value of each implementation hour in euros that can be gained by processing the work package. This prioritization was sensible and helpful, particularly for the sequence for implementing quick win measures, which flowed into the current series during product maintenance.

Gantt Diagram:

A Gantt diagram was used that was updated during regular core team discussions in order to support visualization of work package processing and work progress.

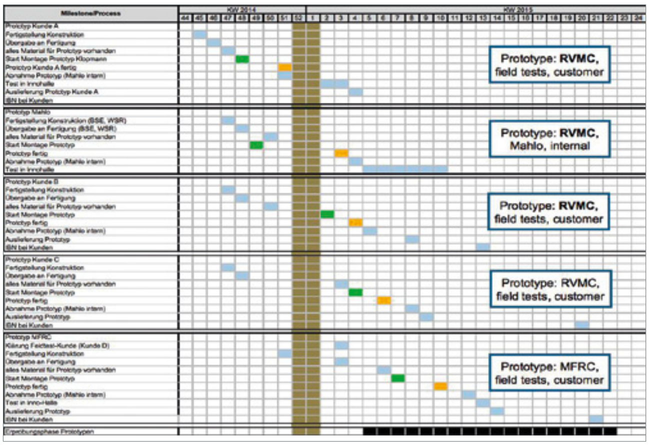

Figure 12: Project plan (Gantt diagram) in the implementation phase

8.4 Implementation Challenges

Complexity of Implementation

The implementation of measures and work packages was initially planned only for the RVMC straightening machine generation 12. However, individual measures had stronger impact on the other available straightening machine types from the MAHLO product portfolio. The planned conversion to a new straightening machine generation 15 had drastic impact on all straightening machine types. This effect could not have been known in detail at the beginning of the project. Therefore, the scope of the project had to be expanded in the implementation phase in order not to view the straightening machine in isolation.

This led to changes in time and resource planning in the implementation phase. However, this also changed the positive monetary effects since potential could also be realized with the other machines. Through the close coordination and the interdisciplinary composition of the team, this challenge could be successfully overcome.

Changed Potential Relative to Estimates in the Design Phase

In the design phase, all measures were evaluated to the best of one's knowledge and belief, and the respective potential was determined or estimated. During implementation, in a few places differences emerged between the forecast and batch costing. Not all potential could be realized to the fullest extent. Here the main task of the project team was to "stay on the ball" and create a corresponding offset, which succeeded very well in most cases.

For example, a few suppliers were unable to maintain the prices indicated in their offer and therefore in the determination of potential for various reasons. As an offset, it was sometimes necessary to involve other suppliers over the short term or to intensify cooperation with previous suppliers.

Increased Demands on Internal Communication
The scope and ambitious objective of the project also placed increased demands on internal communications within the company. In order to overcome challenging and ambitious project phases, the temporary introduction of tightly synchronized regular communication beyond team discussions turned out to be sensible and expedient.

9. Result and Summary

It was possible to complete this project successfully over a total period of 2.5 years and introduce the new machine generation 15 for the entire product family. As an interim step in the project, a cost-optimized machine variant of the straightening machine was developed and introduced in the course of product maintenance. A large part of the potential had already been realized 15 months after the beginning of the project.

Feedback from the field tests of the new machine generation was extremely positive. This speaks to the high quality, capabilities and potential of MAHLO's product updates and re-engineering.

A key factor for the successful work was interdisciplinary teamwork and related internal communication. In certain project phases, institutionalized communication (the introduction of regular internal meetings) was extremely effective and expedient.

In many case, working on this project meant an additional burden for the employees. This challenge was accepted willingly and with dedication, and it resulted in a successful and excellent outcome.

The success of the value analytical re-engineering of the straightening machine has already been demonstrated through a variety of follow-up calculations. Contrary to the overall trend, MAHLO's material cost rate declined despite general cost increases.

Therefore, the further expansion and intensification of value management activities are the right path for MAHLO to a sustainable and successful future.

Source: VDI Conference 2016 (Association of German Engineers), Munich