LEAN MANAGEMENT METHODS PREVENT DEFAULTS ON PRODUCTION AND RECALLS OF VEHICLES ON ROAD

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Annotation: This article discribes an overview of variables on production quality in the automotive industry and influences regarding vehicles on road which can be reduced or avoided by Lean Management methods. Consultingreferred cases, factors of influence and their impacts on the creation of value will be shown.

Abstract

Influencing factors can have such an impact on planned production processes and the outcoming products, that you have to deal with possible defaults on products. If you are able to identify those parameters and quantify their consequences, you can direct better the running and successional processes and avoid possible mistakes like product recalls.
This article reffers to consulted cases, practice related factors and their mode of action due to value creation. Furthermore is explained how waste as far as possible and product defaults, which are caused by lean management, can be avoided.

Keywords: Defaults on products and production, product recall, trends, Automotive industry, Automotive supplier, Lean Management, Lean Production.

1 Introduction

Not a single day passes, on which a manufacturer has to recall one of his products because of inspection, maintenance or repair or even immobilize. Defaults of products cause spectacular recalls in the automobile industry and damage running into millions. However corporations can alliviate the danger by using consequent quality management, traceability of products and surveillance of suppliers.
Product recalls do not only cause costs running into millions or even billions, but can also damage the image of a company permanently.
If effective product recall strategies are not prepared well enough, a recall can in the worst case ruin the own company.
The network of the automobile manufacturers and their supplieres got tighter over the last few years. Because of the outsourcing of tasks to supplieres and the manufacturing process got more and more complex, which bares high risks. One of many thousand components, of which a car is built, can be the cause for a recall. Therefore the suppliers of the automobile industry have great responsibility for recalls.
The product structure is effected by the OEM philosophy: with functional emphasis to optimize product features, with emphasis on design for manufacturing and assembly for raise of efficient production and decrease of total costs or emphasis on electrics and electronics.
After all single diciplines dominate the product structure. In the past this has been the carriages' development in the OEMs (geometry).

In the course of raising parts of electric and electronics, regarding the whole value creation, the domination of geometry fades more and more. This reflects the ambiguity of handling product data: developement- and product-structures are not clearly fixed from concept development on and/or are not distinctly provided to support the process.

2 The problem

To ensure the future on long term basis for companys, which are in intensifyed competition, like automobile manufacturers and supplieres, recall processes are of essential meaning, as the traceability of products supports the planning and the arrangement of a company's network significantly.
In an accelerated and stronger way than in the past managements have to face new challenges. Former developed concepts do often not suffice as an answer to new questions, which arise in globalization.
In this respect it is useful to look for new methods of resolution and to take advantage of the others' expercience.
Thereby the number of recalls in the automobile and supplier industry gained great attention in recent times.
One of the most important challenges is, to cope with the serious changes and high dynamics in the socio-cultural, technological, economical, financal and political-legal areas of the companies and to fulfill novel tasks in a more and more aggressive market, in which the companies have to stand up to.
Many reasons point out, that the number of recalls is going to rise. The data of the German Federal Motor Transport Authority (Kraftfahrt-Bundesamtes) show an alarming, steadily ascending tendency of recalls (source: Kraftfahrt-Bundesamt, annual report 2008). Figure 1 shows this expansion of recalls from 1998 to 2008 in an overview.
Reasons of this expansion are the shortened products' lifetimes, cut down development times, higher technological complexity [1], as well as the untimely introduction on the market because of the ongrowing pressure of competition, which aggravates more and more from the East (for example Poland, Slovakia, Czech Republic, Rumania, etc.) and the Far East (for example China, India, etc.) the market situation. Further it is often not possible anymore for the products users to detect product specific deficiencies and to prevent possible damage, because of such high technologcial complexity of the products.

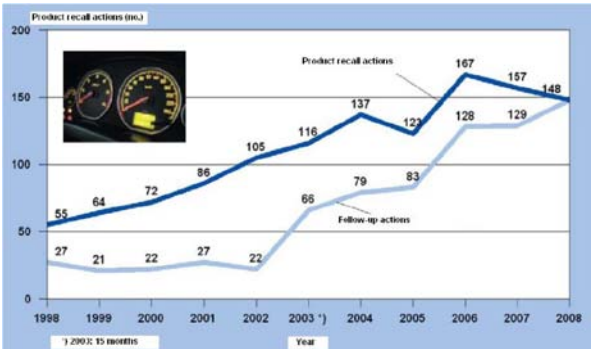

Figure 1 Product recall activities from 1998 to 2008. [13]

Increasingly an integrated process-optimization is therefore neccesary. It not only appers supportingly for a shaped early warning system, but it even is supposed to avoid or reduce demands regarding Lean Management as far as possible prodigality and so called check actions, re-flesh actions or replacement actions, caused by product defects.

Products' security is definitively supported by traceabilty. A product recall emerges not only from a well-planned early warning system and by trying to meet the expectations- and by applying it straight dogmatically- but by possesing knowingly the exact identification of the products and their risk evaluation with the subsequent risk rating of the amount of the recall measurement, which are going to be shown in this article [7].

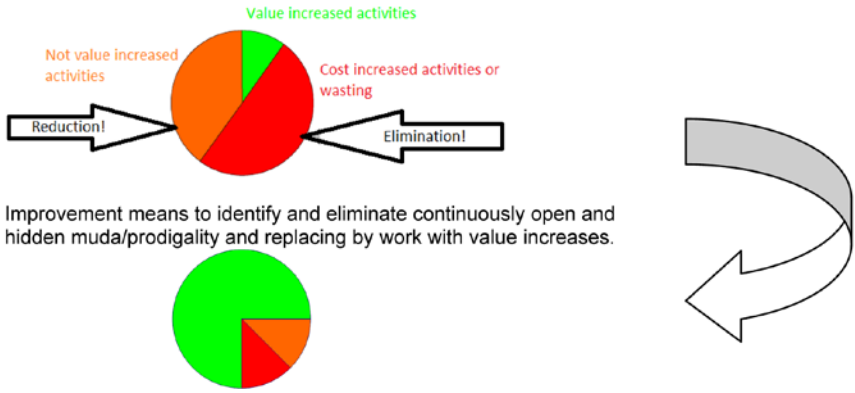

Figure 2 Overview of value increased and not value increased activities in a value stream chain [14].

3 Parameters (in production, product complexity, global logistics, etc.)

3.1 Overview of parameters

The Ishikawa-diagram is a demonstration of problems in a compact form, which points out the causes logical and classified. The question which cause leads to what destinct process is answered. By working interdisciplinary various causes of a problem get connected. The Cause-Effect-Diagram can be developed in groupwork or with the help of brainstorming, so called creative techniques. At the beginning a short intelligible description of the problem needs to be developed, which should contain information about content, time, place and magnitude of the problems. Possible noted factors (causes) are collected to a certain problem (effect) and divided into main- and sidecauses and then displayed graphically (connections between the causes become visible). By working interdisciplinary different causes of a problem get connected to each other. The categories for possible causes can be defined by the 4-M or the 6-M or the 7-M method: man/human, machine, material, method, management, measurement and milieu/environment. By evaluating the single causes focuses (priorities) can be found.

3.2 Parameters in detail (including problems caused by regarding product recalls)

3.2.1 Technical aspects

Since the 80's the product life cycles of the car manufacturers shortened significantly. Thus development and start-up phase corresponded to one period of six years. Today this span for a new vehicle is at approximately four years. For facelifts, which use an existing building group from chassis, etc., the development time lies already today at approximately three years. Virtual development processes make a substantial contribution for the reduction of the development processes. In particular by virtual assemblies and test methods can be done without time-consuming and costly manufacturing of physical prototypes.

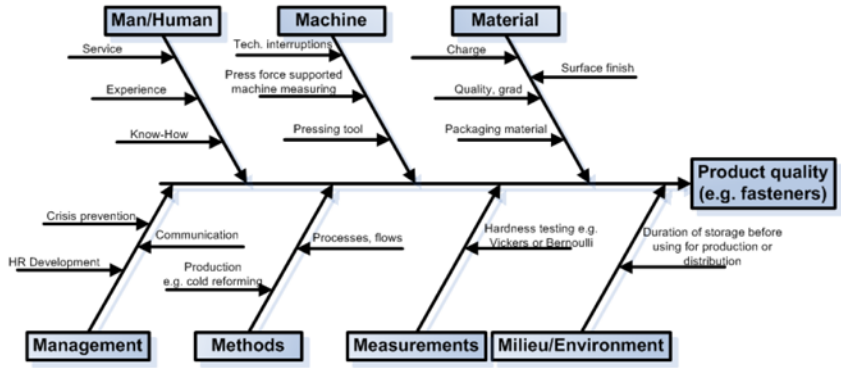

Figure 3 Parameter influation to the product "fasteners".

The contraction of the market cycles resulted from a customer's request-conditioned increase product and technology-referred alteration rates and leads thereby to a fast aging of present products at the market by new (improved) substitutes. As long as the customers honor the innovative progress, the trend is lasting and an accordingly aligned strategy successful. As the further indicator for the today's time competition is to be determined the trend that companies reduce the "time-to-market" drastically because to begin later with the development, ensure an early market entrance for the innovations and the patentability of the products as well. This trend is shown in the following figure 4.

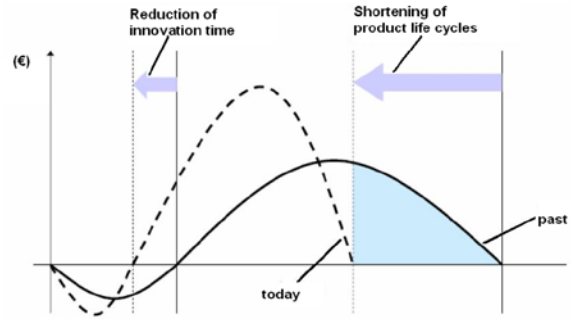

Figure 4 Shorter product life cycles require higher innovation speed.

In future the OE suppliers will be involved more and more in the development, construction, logistic, premontage, etc of new technologies, systems and vehicles. They will promote the innovations in the vehicle development enormously and increase their value all the time. The displacement can be seen in figure 5. The flow of value gets in this way more and more complex because of the higher complexity of assembly groups and vehicles. Therefore the OE suppliers contribute to great expanse to this strategy because of their expierence, strength of innovation, high product quality, as well as efficeny of their own organization.

The world of work has changed and is still changing because the organizations of work are changing their ways. At the same time the organizations are having a adapt to a changing world of work. In 1989, Charles B. Handy proposed a model of the future organizations. A "shamrock organization" [4]. This model consists of three "leaves", each of which represents a set of individuals who make up the sum total of the organization's workforce. This is represented in figure 6.

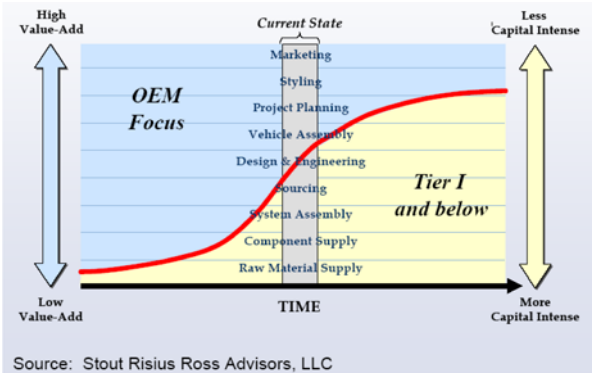

Figure 5 Development in OEM Focus [15].

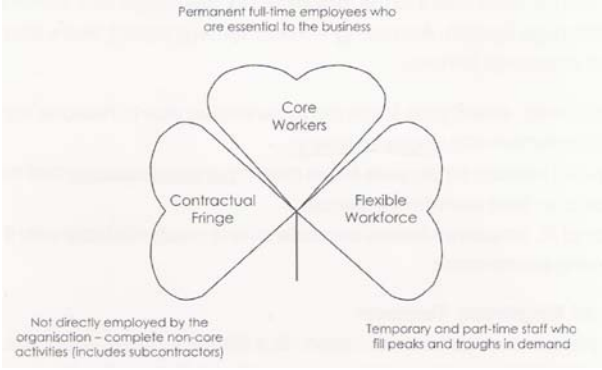

Figure 6 "Shamrock organization" [4].

Many organizations have now moved towards this flexible model, which has enabled them to become much more adaptable to environmental and organizational change. A key activity in any organization is the recruitment and selection of skilled, qualified, competent and experienced people to work in the business. Yes, temporary staff from temporary employment agencies can be skilled, qualified, competent, etc. but not really experienced in-depth with the work like a long working core worker. Flexible workforce have to made the same work like core workers with a short or even without a settling-in period. It is in question if a flexible worker is able to monitor, control or handle complexity regarding logistics, distribution, processes or even products. In our time of turbulent economic companies have to respond quickly and fill peaks or workforce lacks. Sometimes flexible workers do a job which have to be done just be core workers because of special education and/or lang work experience. Because of these and/or other reasons you can have quality discrepances or even a product recall.
A further potential negative issue could be that mistakes, omissions and risks can be occured by such complexities, especially if products are developed and produced by humans under time pressure during ever shorter development periods (see 4) and in processes which are not completely defined. In addition, there is a responding to the expectations of an increasingly well-educated workforce, attention has turned to the role of the employee within a more participative workplace. In this dynamic environment, leaders are moving away from the "command and control" philosophy to a "lead, coach, and counsel" framework. That means that delegation involves allowing subordinates to make decisions (and sometimes to be wrong!).

Causes within the organization could be misunderstanding (objectives or boundaries poorly communicated), inaction (subordinate lacks confidence), incompetence (lack of preparation and training), abuse (subordinate oversteps boundaries), foolhardiness (poor judgement by subordinate), etc. which makes things difficult. You must anticipate product errors which inevitably cause even a product recall within all potential sales channels. But as the case in real life, everything has its downside. The product may have moved further along the supply chain and than immediatelly to your customer, e.g. from manufacturer to the wholesalers and retailers. Consideration should be given to this problem when your Product Recall Plan is made. Essentially the product is beyond your control, and action needs to be taken to stop the product reaching the consumer. Subject to the level of risk, this can be handled by initiating product recall procedures and taking appropriate steps to ensure consumers are made fully aware.

3.2.2 Factors of formation

A far-sighted HR development is the basis for innovation ability of companies. Who oversleeps this trend, drops back!

Truth in Enginnering is the credo of a well-known car manufacturer who will shown the lead by technology. Such a projection presupposes a strategic personnel development. Because the best heads are the drivers of a successful corporate strategy. Fact is that the purposeful development of knowledge is at the beginning of each innovation. However in many companies knowledge, innovation, etc. still do not have a general place! The competition around the intelligent heads will be more and more sharply. In particular in the automotive sector. Thus the increasing complexity of the processes and products also the fusion of the fields of knowledge makes a long-term personnel development to the key for innovations. Already in the school time have to be placed the correct switches. Finally, in Eastern Europe, China and India well trained university graduate are available to take over the jobs from the "old Europe". The requirements in the world of employment grow faster than many conscioused. Rapid internationalization, shorter product lief cycles, frequent change of job and positions. All these make the topic "Personnel Development" to a central function of the management. Anyway the number of engineer functions is rising and a classical diploma training is not enough any longer. *Knowledge-intensive occupations* have experienced a boom in the past ten years, and jobs for *knowledge-poor occupations* were strongly reduced. Particularly in the sectors electronics and in the automotive industry the demand for higher qualifications is increased strongly above average. This knowledge intensification of the world of employment will continue!

This development is a chance for the West and the high-wage country Germany. The number of radical innovations in the automotive industry is increasing. The trend shoves and gives hope to secure high wages and social standards also in the age of the globalization. Lead by education!

4 Practical oriented approaches (due to lean management)

The M7 is used in particular within the scope of team work during the phase of development and planning, where rarely numeric data is available. They demand an orded procedure regarding the problem's investigation and sovlation. Even though the single tools can be deployed independently in an effective way, their full benefit is displayed only in a combined application. They are combined to support the building upon all phases of a problem's solving process and to interact. In opposite to the seven elementary qualitiytools the aim of the M7 is to order a series of unmanageable information, mostly in verbal form.

The relation-diagramm offers an arranged demonstration of the relation between cause and effects concerning various aspects of a problem. After collecting possible factors of the problem their relation is detected. Is there an impact between two factors, an arrow is drawn from

the original point to the other point. A high number of leaving arrows display an important cause. A high number of arriving arrows however show an important effect. Causes lying in the first level concern the problem directly, while causes of the second and third level affect the upper-lying causes. Ishikawa does not show the importance of the causes (levels).

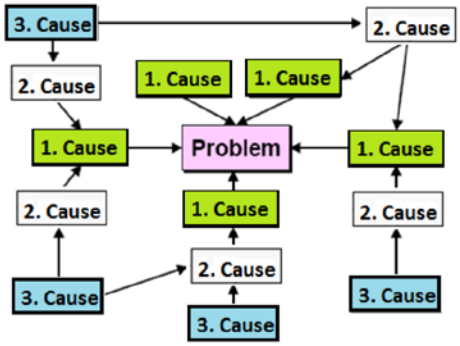

Figure 7 Relation diagram.

Lean Management is supposed to increase the ability to compete by:

- Decrease of costs,
- customer oriented and
- high defined quality standards.

The seven ways of prodigality and the preventive lean methods, which need to be applied, are shown in table 1. A direct contribution to avoid mistakes and the resulting prodigality of production defects are for example Poka-Yoke or Zero-Mistakes-Methods. In this way it is preventivly avoided, that after works (like heck actions; re-flesh actions or replacement actions) need to be taken or in worst case withdrawals or recalls, as defects are recognized too late.

Table 1 Overview of ways of prodigality (Muda) and preventive Lean-Methods.

Seven ways of prodigality (Muda)	Preventive "Lean methods"
prodigality by overproduction	One-Piece-Flow, Mixed-Model-Production, etc.
prodigality by waiting	Muli-Machine/Process handling, Material flow in U-Layout, SMED, etc.
prodigality by transportation	Material flow, Just in Time, Production/Value/ Process orientation, Pull control, etc.
prodigality by poor defined process	Kaizen, Quality cycle, etc.
prodigality by high inventory	Just in Time, Pull control by Kanban, cycle time, etc.
prodigality by "round trip" moving	6S concept, standardisation, etc.
prodigality by production defaults	Zero-error method, Poka-Yoke, internal customer/supplier relationship, standardisation, automation, etc.

4.1 Disclosure of weaknesses

4.1.1 The actual condition

Successful companies integrate suppliers more and more in the whole process of value adding. The pressure increases by shortened developing times and overtaking of more and more developing features at the same time, but by increasing raw material and material costs as well. Sennheiser electronic integrates for example his supplier management in the quality control circle. So the supplier gets assisted and demanded. These duties are passed on to the

suppliers. Another example is the compliance with the guideline 2002/95/EG regarding the restriction of the usage of certain dangerous substances in electro- and electronicdevices. In this way Sennheimer accomplished monitoring the RoHS status of all suppliers and adjusted the contracts with the suppliers.

How can a manufacturing without any defects be secured already from development of the product on?

To solve the problem a long known method is used – the principle "try and error", which means you try something different and wait what happens. Only a few number of teams get to the bottom of such problems with systematic and consequent, to stop them subsequently. If you, for example, are working with the same supplier for many years and got many products onto the market, you get a posivite feedback of all participants. The result was the comprehension, that the working effort was worth it, no matter the size of the supplier's company. The level of awareness has nothing to do with the size of the company, but with the demand to produce successful products. In the following scheme possibilities are shown, how to implement this:

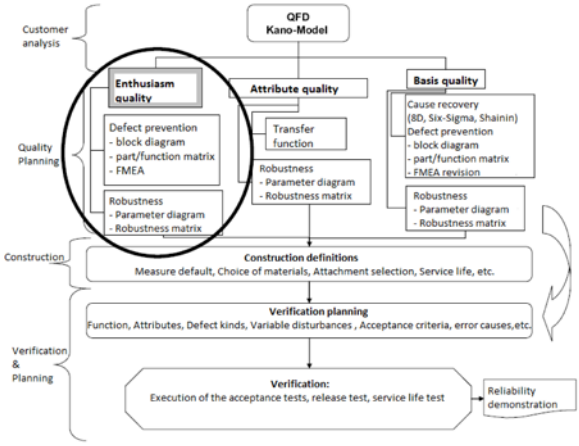

Figure 8 Whole overview of quality application in product development.

At Fresenius Medical-Care the management of risks is seen as a constant task and the acqusition, analysis and management of those is an important part of leading the company since many years. Part of the strategy of the concern is a risk managing system, which is based on the following foundations: an intern surveillance system, a risk controlling and a there from derived early warning system, which detects developments, that can endanger the cooperation, at an early time and avouid them. In the single branches of Fresenius Medical care the factual, as well as the potential risks, got identified and the ones responsible for the process chain and the surveillance named:

- The state of risk is collected on regular basis and standardized and compared with existing guidelines.
- So counteractions can be taken in time, to prevent negative developments.
- The responsible executives are commited to inform the management about relevant changes of risk profiles immediately
- By constant monitoring the market, as well as good contacts with clients, suppliers and other institutions changes of the enviroment can be recognized shortly and reacted to quickly.

More over the risk managing system is part of the annual audit of Fresenius.

4.2 Approaches of improvement

4.2.1 The ideal condition

Discloure of improvement potentials for example by TPM (total productive maintenance) improves the effectiveness of the equipment by involving the staff actively in optimization of maintenance processes (preventive, foresighted and suitable), decrease of blunders.
A pracitcal example comes from the company Egston in their convention of quality to ensure the supply-quality of suppliers. There product features with special impacht on safety, function, further development in product specification are defined comprehensible., as well by Egston, as by the suppliers. It is determined, that the supplier implements for all his manufacturing processes processes' FMEA, plus constructions' FMEA for all parts, which he has the responsibility of construction vor. Various factors, which influence the manufacturing process, need to be considered. Likewise precautionary measures need to be taken, if weaknesses are detected. Further measures of the convention of quality:

- Supplier defines a convention of control in own responsability
- Supplier commits to use proper statistic methods for surveillance of the manufacturing process regarding the process capability (for example with critical features, which can only be tested destructively, it needs to proved statistically, that the distance of the average value to the limit value exceeds the standard deviation five times. Im comparison: A standard deviation of six times more match the in the automobile industry often demanded "six sigma")
- Supplier commits to use surveillance methods, which foreclose the delivery of defect parts (Poka Yoke)
- If the supplier realizes, that he cannot comply with the conventions made, he is commited to inform Egston about it and needs to reveal any data in interest of a quick solution.
- Supplier is commited to draw records (documentation) of data and test results
- Supplier ensures traceability and complete detection of quality of all fabrics, manufacturing processes and prodcuts by taking suitable measures concerning prodcut marking
- Supplier pays attention to compliance with the FIFO principales

Other solution are offered by standardization and modularization to avoid increasing complexity of the products. Manufacturing companies have to face more and more the challenge of providing a differntiate programm of products with many versions. This is the ony way to satisfy the needs of the customer and realize a comstumer-fitting solution. The variety of versions is connected with high costs for a company. Because of that the standardization and modularization of components, assemblies and processes get more and more important, as only an economic development and manufacturing, reaching to the order quantity 1, is possible.
An example of standardization of screw fastenings is shown in figure 9. In best case, thread diameters of row 1 should be favoured. Threads in () belong to row 3 (not shown in the figure) should be avoided. See DIN 13 T28.

4.3 Results

The introduction of a produciton system puts high demands on a company regarding the systematic of the procedure and the organizations of a project. The aim of a production system however is the penetration and optimization of the whole supply-chain-structures and processes. Corresponding the realizable potentials are enormous. By applying a set of measures, combined from flow-optimating layouts, decrease of order quantities during subassembly, pulsing of final assembly and a consequent tight dimensioning of stock, some companies of the metal processing industry achieved substancial progress, for example: 70% shortened running times, almost 50 % decreased WIP stock (work in process) and more than 80% cut down on accounting work. At the same time routes for staff were cut down about 40 % and the area for assemblies decreased about 30%. Results that more than justify the expense of introducing a new production system in the course of "smart manufacturing".

Nominal thread diameter d = D		tread	Pitch diameter	Minor diameter		Thread depth		Tensile stress area	Core cross area	Pitch angle
Line 1	Line 2	P	$d_2 = D_2$	d_3	D_1	h_3	H_1	A_s mm2	A_3 mm2	φ
1		0,25	0,838	0,693	0,729	0,153	0,135	0,460	0,377	5,43
1,2		0,25	1,038	0,893	0,929	0,153	0,135	0,732	0,626	4,38
1,6		0,35	1,373	1,170	1,221	0,215	0,189	1,27	1,075	4,64
2		0,4	1,740	1,509	1,567	0,245	0,217	2,07	1,788	4,19
2,5		0,45	2,208	1,948	2,013	0,276	0,244	3,39	2,980	3,71
3		0,5	2,675	2,387	2,459	0,307	0,271	5,03	4,475	3,41
	3,5	0,6	3,110	2,765	2,850	0,368	0,325	6,78	6,000	3,51
4		0,7	3,545	3,141	3,242	0,429	0,379	8,78	7,749	3,60
	4,5	0,75	4,013	3,580	3,688	0,460	0,406	11,3	10,07	3,41
5		0,8	4,480	4,019	4,134	0,491	0,433	14,2	12,69	3,25

Figure 9 Example of standardisation in fastenings.

4.3.1 Prodigality and loss in production

TPM (total productive maintenance) improves the effectiveness of equipement by involving staff actively in optimization and maintenance processes (preventive, foresighted and suitable), decrease of blunders and non productive times and increase of reliability at the same time.

4.3.2 Autonomous maintenance

Traditional responsability:

- Manufacturing of the products (number of pieces and quality) by produciton staff,
- Maintenance, servicing and repair of the equipment by maintenance employees.

Goal of the autonomous maintencance is the assignment of part of maintenance measures upon to the machine operator.

5 Conclusion

Concluding can be said, that the preventive focus on decrease of blunders and increase of reliability involves economic success and is verified in pratice the whole way. The cooperation of lean management and systematic monitoring of quility no abnormalities and product defects remain undiscovered.

The aim are robust and therefore failure-free systems to avoid mistakes in the fist place and their onmovement through the supply chain. Defects in production cause in-plant reworking, rejections or reorders – outside the company quality defects cause withdrawals from large consumers (Tier 2, Tier 1 or automobile manufacturers) or recalls from the end customer. They are prodigality and ususally not irreversible, as it is not always possible to fabricate a good product from poor material. To ensure a high niveau of qualtiy for the end prodcut (aim is 0-error) the quality standards of raw materials, machines, tools, etc. need to be higher. The consequendes of production defects increase with the distance of place of added value and meet the highest point, if they appear to a end cosumter (to the point of recalls). Mistakes cannot be controlled away, as a quality test does not reduce the costs that arise from defects, but help to avoid the consequendes at the customer.

Companies, that avoid non value adding running times, surplus materials and production defects, meet the expectations of the comsuer markets. However there are companies, that will not adjust to this needs. Reasons for this lacking willingness to change and the speed to change are various. They have to be analysed and mearsures to their removal have to be taken.

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