Grothaus, Hans-Peter; Friedlein, Frank-Ulrich and Dirks, Matthias

Repair is plannable

Beside the sales of agricultural machines services are of major importance for CLAAS. Operational reliability and availability of CLAAS machines, performance of value-adding services and the preservation of customer satisfaction motivate to enhance the service business. CLAAS aims to offer services for the complete range of products. These services covering the lifecycle of the machines are directed on individual customer needs. Integrated/hybrid service offers are created by interlinkage of technical products with „intelligent“ services. These integrated service products are based on modern information and communication technologies.

Keywords
Repair, repair strategy, condition monitoring, field test

Abstract
Landtechnik 64 (2009), no. 3, pp. 184 - 186, 6 figures

Compared with the automobile and commercial vehicle branches the agricultural machinery sector is characterised by lower unit numbers but at the same time higher unit variation. Depending on machine application – and especially on the marked regional variations in environmental conditions – there are major differences in the servicing and maintenance inputs required.

The requirements of the machinery user, mostly a farmer or a contractor, from the manufacturer and the farm equipment workshop as service supplier are:

a) low costs for ensuring operational readiness,
b) limited machinery downtime, and
c) high reliability and constant readiness for work.

Additionally, the machinery user wants support for the efficient operation of machinery – and this is given through training opportunities and advice regarding optimum machinery settings.

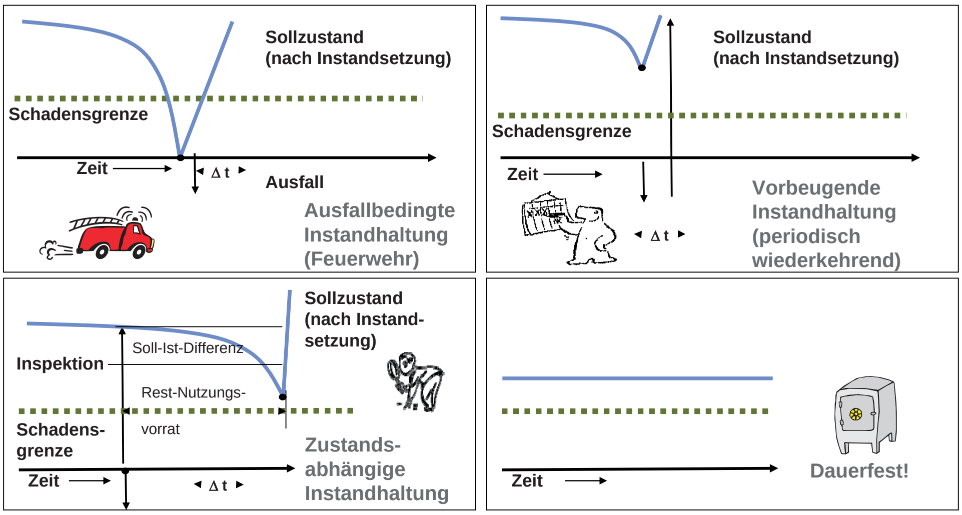
Progressive development of work capacity in farm machinery means customers increasingly demand constant operational readiness. This is because increased working capacity means fewer implements are required for the same area and, with fewer implements, the risk of missing a window in the crop production calendar through machinery downtime increases. Through continuous improvement measures in product development, maintenance costs decrease in relationship to investment costs.

Usage of machinery and plant results in predictable and unavoidable reduction of the predetermined wear reserve, a situation described by a theoretical material loss curve.

Maintenance strategies

Depending on the selected strategy, maintenance takes place at different times along the material loss curve for wear reserves of a machinery part or groups of parts, see **figure 1**. Traditionally, repair takes place following breakdown. In such cases a rapid and reliable return to operational readiness is important. Another strategy is used especially with crucial components or component groups where such parts are very strongly built to avoid, as far as possible, breakage during lifetime of the machine. An alternative is preventative maintenance, often working best in association with inspection and servicing. Important in the selection of the right maintenance strategy is an ongoing assessment of all machinery parts, groups of parts and components.

Fig. 1



Maintenance and repair strategies

Maintenance timetable

Maintenance and repair services follow a permanently repeating procedure beginning with identification of necessary actions and ending with their administration and invoicing, see **figure 2**. Reflexive mechanic/traditional maintenance and repair methods (green line) require limited planning input although they have an especially high administrational demand.

The inputs for maintenance and repair alone, plus documentation and invoicing of workshop costs, can be substantially reduced (orange line) through minimally higher planning input for planned and standardised procedures giving a reduced input in total.

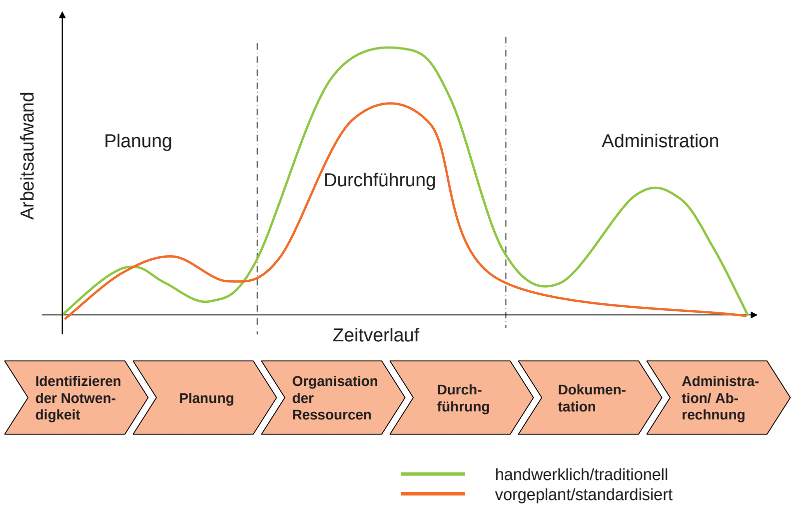
Bundling information

A farm machinery manufacturer that wants to offer cost-efficient maintenance and repair over the complete machinery lifetime must collect as comprehensive information as possible regarding application and usage. Various information sources are available for this. Usually, manufacturer research departments record the results of many different tests on function and robustness. Additionally, adding sensors to machinery offers the possibility, in agreement with the owner, of recording and analysing data. And after-sales service staff and training centres offer comprehensive feedback from machinery already on the market. This can be filed and processed. Maintenance and repair information can also be calculated from replacement part turnover and breakdown statistics. If test machinery is involved in a telematic infrastructure this then allows monitoring of sensor values under work conditions with information on warning signs and breakdowns. Included in service contracts is the complete maintenance procedure professionally accompanied with electronic recording and storage for billing and documentation reasons. The bundling and intelligent analysis of this information is fed back into the early phases of new machinery production towards further improvement of quality and maintenance procedure over the entire lifetime.

Planning maintenance with example of chain elongation

For example, chain elongation of combine feeding house conveyors (**figure 3**) is an important factor in service and maintenance. Working with the combine where the chain exceeds wear limits leads to the part breaking. The serious primary

Fig. 2



Traditional versus preplanned maintenance and repair processes

Fig. 3

Feeder house conveyor chains

damage thus caused is acerbated by the possibility of considerable follow-on damage to part groups such as the threshing mechanism, rotor or walkers and straw chopper. The repair costs and the machine downtime are consequently higher. On top of this can be added the costs of the lost harvesting time.

Under normal working conditions the feeding house conveyor chains are in contact with various materials including sand, vegetation, oil from oilseed grain and water. These, and the different grain-straw mixes conveyed by the components, all influence rate of chain elongation. There results acute requirement for investigation and analysis of wear and associated consequent breakage predictability. Because of the clearly definable mechanical behaviour (the chain can only become longer) the principle followed involves mathematically modelling rate of wear, and thus remaining working life, of the chain.

Information from test stand research

To validate test method, rate of chain elongation is first of all determined on a test stand (**figure 4**).

For precise data analysis main influences rpm and traction at chain centre of forces are clearly defined and kept constant. Other influencing factors are not involved in the calculation.

The test station investigations indicate that the data on chain elongation can be clearly mathematically expressed through regression analysis (**figure 5**).

Verification with field tests

To verify data quality under real conditions, chain elongation rate is also measured over different periods under field operations with elongation measured using the same methods as on the test stand. The evaluation of the data indicates a similar rate (**figure 6**).

Changing types of cereal, locations and weather conditions appear to have less influence on the procedure as was first thought. Coefficient of determination for the investigated function was high at 0.999.

Conclusions

Based on these results operational guidelines for planned maintenance and servicing of feeding house conveyor chains can be calculated. The required work can be coordinated towards achieving as high a degree of operational reliability as possible. Damage through incorrect use when wear is high can be avoided.

Authors

Dr. Hans-Peter Grothaus is manager for development of systems and services within Claas Selbstfahrende Erntemaschinen GmbH. E-Mail: Hans-Peter.Grothaus@claas.com

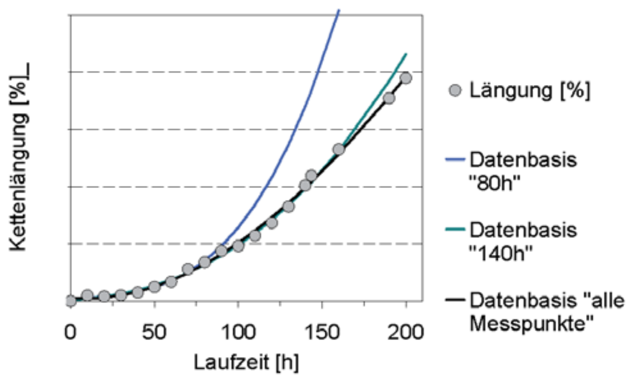
Dipl.-Ing. Frank-Ulrich Friedlein is manager for research, function and reliability within Claas Selbstfahrende Erntemaschinen GmbH

Dipl.-Ing. Matthias Dirks is a research engineer with Claas and responsible for reliability tests in Germany and abroad

Fig. 4

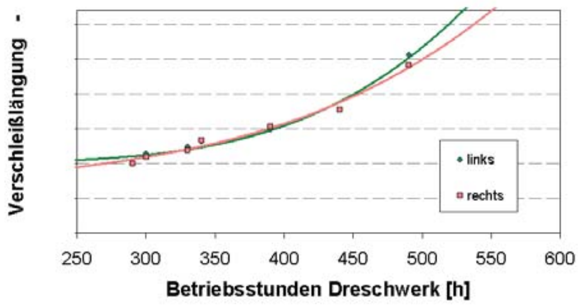
Test stand for feeder house conveyor chain examination

Fig. 5



Chain elongation on test stand

Fig. 6



Chain elongation in field test