Digital maintenance concepts

Predictive maintenance aims to eliminate faults and therefore machine breakdowns as quickly as possible. An even better approach is not to allow the faults to occur at all.

Figure 1: Condition monitoring is a preliminary stage to predictive maintenance (Source: HJS Emission Technology)

Mobile machines are investment goods used by many different parties: Manufacturers and owners, hire companies and operators, project managers and insurers. All of these have a common interest: to use the machines as efficiently as possible. One aspect of many for efficient use, albeit an extremely important and fundamental one, is to achieve as continuous and fault-free an operation as possible, because every standstill is associated with frequently enormous costs. However, without maintenance, faults and therefore machine breakdowns are certain to occur. Thus the object is to eliminate these faults as quickly as possible, and an even better approach is not to allow the faults to occur at all.

In case breakdowns occur due to defective parts on a machine and system, then the respective fault must be diagnosed. The appropriate spare parts must be available and brought rapidly to the location of installation. Accordingly, trained personnel should be able to reinstate operation of the machine within the shortest possible time. If repairs are not executed until a machine or system part has failed, then we speak of reactive or breakdown maintenance.

In almost all cases, maintenance plans are available which should ensure a high level of availability through regular servicing. If a car is not at least brought to a workshop for a regular oil change, then an increased risk of major engine damage is to be expected. Once this has occurred, then a simple oil change is no longer sufficient to repair the damage. Compliance with maintenance plans, which includes the preventative replacement of components prior to their failure or prior to the failure probability rising to an unacceptable level, is called preventive maintenance. Within the scope of such maintenance work, lubricants are normally checked, supplemented or changed, partial or complete overhauls and adjustment work executed etc.

Through diverse use which cannot only be quantified through operating hours, kilometers, or cycle numbers, fixed, defined maintenance intervals can prove too long, and in other cases too short for an individual machine. Furthermore, no two machines or systems are absolutely identical in their construction or setup; therefore only the probability of a component or machine failure occurring can be predicted, but not a defect in an individual machine or component. This probability can be numerically calculated, simulated, determined in tests or estimated from experience with machines in the field.

Figure 2: TC3G – data-logger, gateway, network hub, edge controller – the all-in-one solution for predictive maintenance (Source: STW)

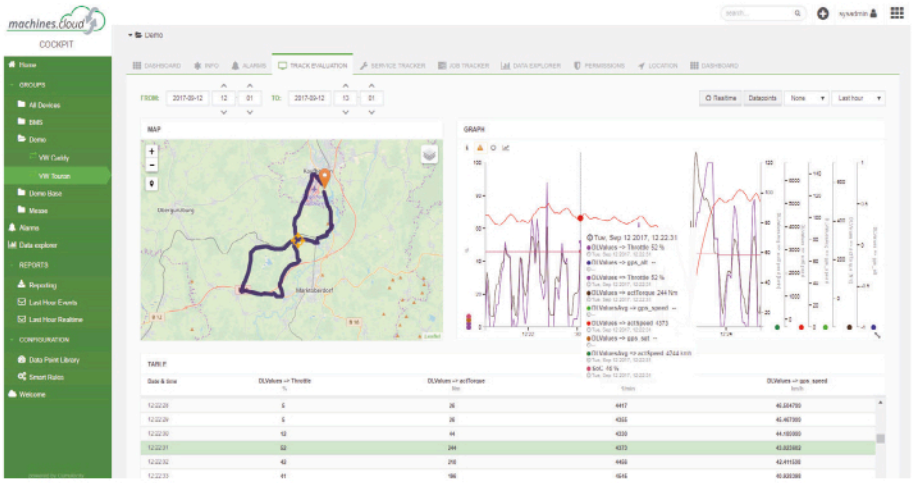

Figure 3: Data for condition monitoring is transferred onto the STW IoT platform machines.cloud (Source: STW)

Increasing digitalization and connectivity enables a gapless monitoring of machine parameters and therefore of the condition of the machine. Condition monitoring enables wear criteria to be derived from measurement values of an individual machine. As a result, the length of a drive chain can be continuously monitored, and on reaching a defined value, the delivery of a new chain is already initiated and an appropriate maintenance slot reserved for the execution of the replacement work. In this way, failures can be avoided in advance, i.e. preventatively. This is designated as predictive maintenance.

In particular with predictive maintenance and the associated condition monitoring, the recording of physical factors such as pressure, temperature, force, accelerations, and speeds is indispensable. This data is first stored on the machine together with other parameters, such as operating time, completed distance, braking procedures or the number of movements. The medium for the transmission of this data on a mobile machine is mainly the CAN network. Often, the data is also transmitted on different CAN networks. As a result, it is possible to differentiate between information for the driving operation and for the work function, or, in case of an electrified machine, for the energy management.

In order to use the CAN data, an interconnection of the machine is required, and for this purpose the TC3G is equipped with wireless communication technologies. Internet-based services can be used via WiFi or mobile telecommunications. Establishing a VPN connection from the office to the machine on top of the IP link allows technicians to transparently access the CAN and therefore work directly with sensors and actuators from any office around the world.

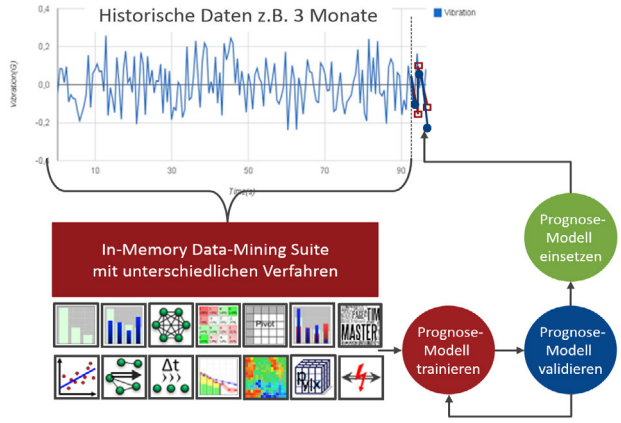

Figure 4: Data mining and forecasting procedures identify untypical conditions prior to occurrence of a failure (Source: Synop Systems)

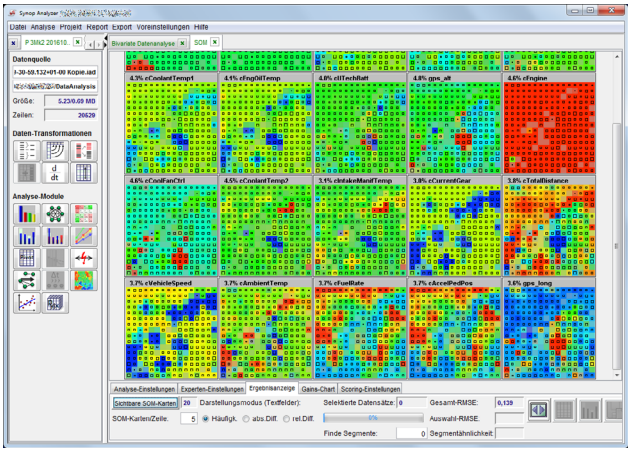

Figure 5: Neuronal networks are used in predictive maintenance (Source: Synop Systems)

Diagnose tools can be used as if one would be in front of the machine with a laptop.

The TC3G also allows to record CAN data. Using the IP link, the CAN data can be transferred to dedicated servers or cloud services. We differentiate between public, private, or hybrid solutions for cloud services. Sensor-Technik Wiedemann (STW) provides their customers the use of the IoT (Internet-of-Things) platform machines.cloud, which has the advantage of openness regarding interfaces, scalability, and flexibility with respect to the hosting model. The open interfaces permit the transfer of CAN data to other servers or services. Here data evaluation, recognition of patterns, and also feedback that a fault is impending occurs.

These patterns can only be identified using methods of data analysis due to the large data volumes – Big Data – from many machines of one type. Mostly, a pattern can only be identified after one or several fault cases. For this purpose, the successive improvement of the algorithms occurs to further improve the failure predictions. To reduce the quantity of recorded and transferred CAN data through the data analysis, it is also possible to filter which parameters indicate a possible fault case. In the case of a mobile machine, this transfer often occurs via mobile telecommunications and, especially in case of roaming or large data volumes, can incur significant fees. Detection still takes place on a server and not on the machine. To enable this last step, corresponding algorithms are required on the machine which derive smaller but informative volumes of data, i.e. smart data, from the much larger volume of data already available.

Such a derivation of Smart Data would be expedient for vibration and modal analyses, if, for example, irregularities in operation can be deducted from a change in the vibration spectrum of a machine. The transfer of the high frequency-scanned time measurement values – in the frequency range – can take place directly on the machine. The calculated spectral pattern is compared with a specified nominal spectrum, and an alarm is triggered in case this is exceeded. The prerequisite for this is, of course, that the on-board unit is responsible for the recording of data and appropriate processing power is available in connection with the programmability. The TC3G with Linux as the operating system and a freely-available deployment package holds the best prerequisites for this job. Ultimately, a significant volume of data can be saved through the implementation of the algorithms.

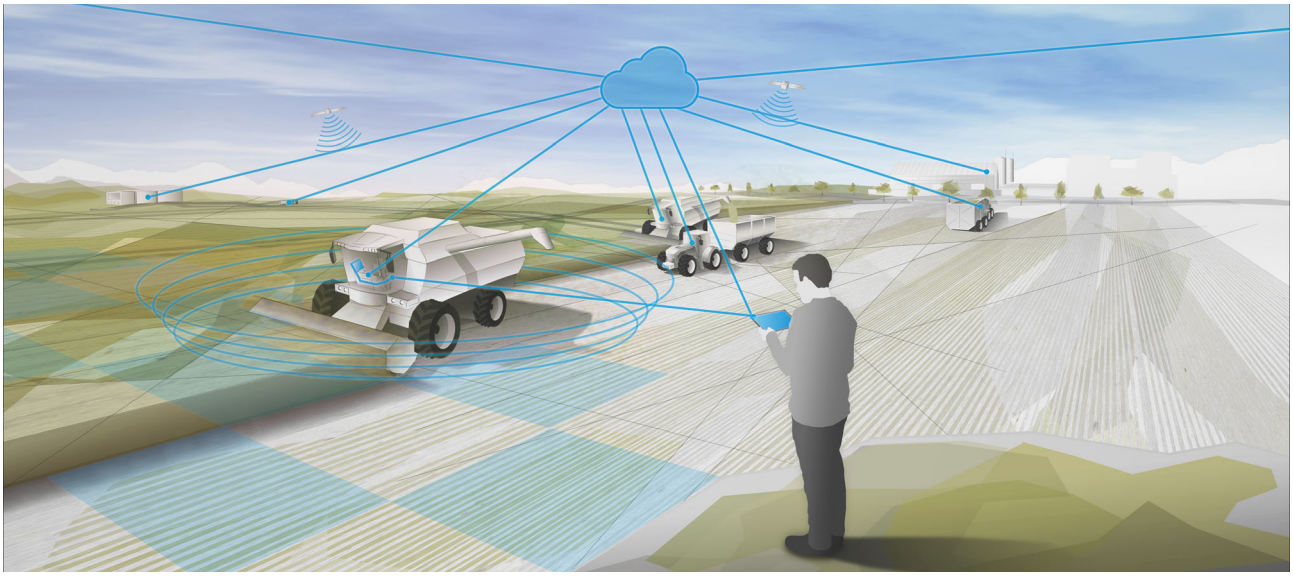

Figure 6: Networking enables access to important data and machine parameters at any time and any location (Source: STW)

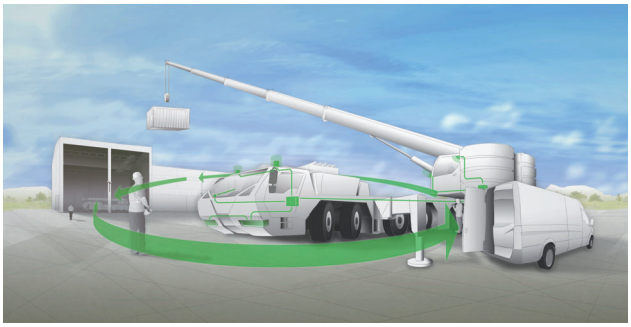

Figure 7: Work processes become more effective through automation (Source: STW)

Figure 8: Sustainable energy sources can contribute to their power supply through the electrification of vehicles (Source: STW)

It should not be forgotten that there are also further fields of interest and tasks in the environment of mobile machines. Depending on the point of view, information is required on the operation time for the purposes of invoicing, the transfer of orders and their processing for logistics, or simply path-tracking for monitoring occupational safety. With the transmission of basic data to machines.cloud, which can take place parallel to the calculation of Smart Data, ERP systems can for example be connected so that each interested party receives the data they require.

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