Digitization in lift construction – Will the lift engineer become a leftover?

UK

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Large data volumes alone do not inevitably lead to automated systems – but (next to the domain knowledge) they are an important footing for the development of new systems in elevator engineering. (Pictorial source Henning)

Digitization is the new growth area in all industrial branches. The elevator market, too, is ready to face the chances and risks. Since it is an important part of the turnover, the improvement of the cost efficiency of service deployments in existing elevator systems using digitization occupies a central position. In this context the market is virtually flooded with new anglicisms. Advertising promises and reality are not always congruent. This article will take a look at the different aspects of the „Elevator 4.0", the current possibilities and the effects on the market.

To anticipate the answer to the question put in the title: no, the service engineer will definitely not become a leftover. But whether or not he will still work in small to medium-sized business as a fully fledged elevator engineer is uncertain. The market really risks a dramatic decline of the number of small to medium-sized elevator companies in the next few years, the remaining ones mutating to „record producers of the MP3 age" and only leading a niche existence. The remaining service engineer will surely be able to work more efficiently since intelligent systems already locate the cause of the malfunction and allow an extremely competent service job to be planned without the need for a proficient malfunction analysis.

The classical maintenance of elevator systems / Preventive maintenance

Currently most of the elevator systems are operated with the so-called preventive maintenance system. It goes without saying that a preventive maintenance aims at preventing downtimes. However no data are collected in the system itself (except for data relating to rides and operating hours). Instead the maintenance and monitoring work is carried out at (regular) intervals already determined earlier. Therefore the preventive maintenance is based on the theoretical component failure rate. The maintenance jobs are planned on the basis of calendar dates and/or the elevator's utilization. Since the individual elevator systems and their daily use differ considerably, a preventive maintenance may cause unnecessary service work. And of course one always risks to replace components too early which are still in perfect working order and would have worked for quite some time.

Predictive maintenance

The predictive maintenance differs from the preventive maintenance in that it is based on the actual condition of the elevator system and not on the average or expected service life of the components in order to be able to forecast the next required service. In the predictive maintenance the elevator condition is either constantly registered by several sensor systems or only ascertained periodically. But the

1) Henning GmbH & Co. KG

latter is hardly ever an efficient solution because it requires personnel to be on the spot. Under ideal conditions the predictive maintenance allows the need for a maintenance routine to be recognized and carried out with a maximum cost and performance efficiency.

Predictive analysis modes / Predictive analytics

The predictive maintenance uses electronic data collecting and evaluating units for the evaluation of the sensor data collected in the elevator system and derive the appropriate maintenance information. In this area in particular dozens of new procedures and keywords have been created under the heading “Industry 4.0” in the past few years.

The fundamental problem is the huge amount of data being produced and the need to extract the appropriate information. This can hardly be managed with a human workforce only, particularly in view of the lift owner’s labour costs originating from a classical preventive maintenance. Moreover specialists who are able to draw conclusions as to the elevator’s condition are not available in sufficient numbers.

Large data volumes and distributed computing capacity / Big Data and Cloud

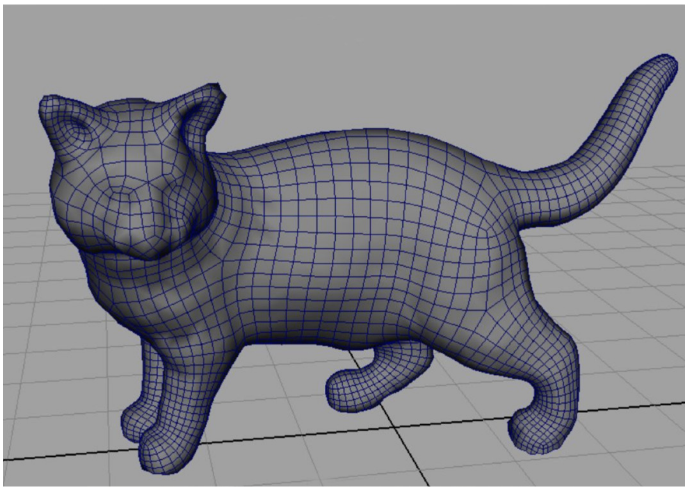
On the subject of large data volumes, keywords like „Big Data“ and „Cloud“ involuntarily come to one’s mind and in this context are exploited especially for advertising purposes. Of course appropriate computer systems are needed to evaluate these data and it is beneficial that this is done also by using a distributed computing power in distributed processes. But simply by loading data into a Cloud and store them there in data base systems convenient for „Big Data“ one cannot draw conclusions about the condition of elevator systems or their components.

And this is where the next keywords of Industry 4.0 come into play: Machine Learning and Artificial Intelligence. Of course, if humanity had reached a point at which machines (or superordinate computer systems) are able to learn independently, the appropriate sensors would simply have to be installed in lift systems and the company’s maintenance concepts would only need to be adapted. But we have not yet reached that point even though initial approaches exist already. The analysis of data requires even more resources and is not possible using computers only. Instead these are often used as auxiliary means together with manual data analyses.

Machine learning is written in Python[2], artificial intelligence in PowerPoint[3]

This sentence is a popular joke among Big Data analysts and says a lot about the discrepancy between the public awareness and reality. One thing is sure: artificial intelligence is on a fascinating journey and is already able to render astonishing results.

But it also has limits and what is definitely impossible today, is to simply present to an artificial intelligence



The artificial intelligence capabilities are amazing and impressive. But this does not mean that the product is comprehensible. An examination of the software logics which is e.g. required for SIL3 applications is not possible.
(Pictorial source Henning)

The usefulness of lift digitization is only fully developed when the results and data from the different components merge into a digital "elevator twin". Common protocols and interfaces are indispensable to achieve this.
(Henning)

some sensor data of an elevator and get back predictive maintenance results because a substantial factor is missing: the feedback. The algorithms first of all have to learn e.g. how to recognize the wear of different components.

Neural networks

In neural networks learning is effected by feedback. When the learning process is completed, an algorithm with thousands of parameters has been created which really fulfills his mission. And usually nobody can comprehend how it actually operates. The feedback in the course of the learning process is extremely important. If somebody e.g. would like to create a neural network which is able to recognize cats on photographs regardless of the cat's pose in the picture, the environment in which the picture was taken, what the cat looks like, the colour of the fur etc., the algorithm is fed with thousands of pictures. Some pictures show cats, some show other animals or objects. During the learning process the algorithm is created by a person telling the program which picture actually shows a cat. The more this is repeated, the better the algorithm learns to recognize a cat until it is able to do it nearly perfectly. But since nobody is able later to determine how the algorithm is able to identify the cat, it is absolutely sure that this algorithm is not perfect. When for example all cat pictures used for learning coincidentally also show the ears and the algorithm has identified these ears as a cat's identification characteristic, it may happen that a cat picture that is unambiguous for humans is not identified by the algorithm as a cat only because the cat's ears are cut off at the edge of the picture.

When looking at the sensor data of elevator systems, this means that neural networks are a good approach to create a predictive maintenance system because in the end they can really learn. So why not also identify wear on elevator components? But how is the feedback done? Who learns together with the algorithms? In extremely rare cases the maintenance reports are electronically gathered to make them suitable as a feedback mechanism for learning algorithms. This is where (and especially in the small to medium-sized companies) a big need for digitization exists. And of course the suitable sensors must be selected first. Only because temperature and humidity sensors collect thousands of monitoring points inside the elevator shaft with which learning algorithms can be fed, this will definitely not create a neural network allowing the wear and tear or impending system failures to be identified – no matter how good these algorithms are trained.

Digital Twins

But it is likely that a combination of many different processes will in the end allow a predictive maintenance based on sensor data. Another principally suitable process is the Digital Twin. „A Digital Twin is a digital representation of a material or immaterial object from the real world. It is irrelevant whether the counterpart already exists in the real world or will only exist in the future. Digital Twins allow a cross-sector data exchange to be carried out. But they are more than just pure data and can also contain models, simulations and algorithms which describe their real world counterpart and its characteristics and behaviour [4] " . For the elevator machine for example one can quite well imagine to collect the physical dependencies of the components in a model. From this model a suitable algorithm can then receive the information how fast and at which speed the cab guide rollers are turning. If one of the (suitable) sensors records a frequency with an unusually higher or a drastically changed amplitude which concurs with the arithmetical frequency at the measured cab speed and if it behaves (depending on the speed) like the modelled guide roller, then such an algorithm will signal a defective guide roller with quite a high level of reliability.

Domain knowledge

Just like in many other branches of industry the lift industry relies on knowledge and experience.

So if one intends to create a predictive maintenance system, at least the following steps need to be taken:

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2) Pogramming language

3) Presentation program

4) Wikipedia https://de.wikipedia.org/wiki/Digitaler_Zwilling

- 1.Identification of the substantial components that need to be monitored
- 2.Selection of the appropriate sensors needed to monitor these components
- 3.Application of the technical measuring processes to allow an appropriate editing of the sensor data (filtration, evaluation, etc.)
- 4.Pattern recognition processes, machine learning, etc., to acquire information for the predictive maintenance
- 5.The required infrastructure to transmit, process and transfer the data to the user

The first step is based on pure elevator knowledge and the next two steps, too, cannot be handled by any measuring technician but require special elevator measuring engineering knowledge. It might involuntarily come to one's mind that the fourth step is far away from the elevator domain knowledge, but this not the case at all. As already mentioned earlier, one cannot just put on algorithms (not even the most modern ones) to such elevator data and expect to get usable results. The last step in particular requires elevator domain knowledge. The knowledge and experience of elevator specialists are required to send out the algorithms to look for successful results. The main challenge is to connect the elevator domain knowledge with the data analysis domain knowledge.

New market participants

Only the fifth step requires no elevator domain knowledge at all. It becomes apparent that companies from the appropriate branch increasingly often try to gain a foothold in elevator engineering claiming to revolutionize the service in the direction of a predictive maintenance. But they usually lack the specific domain knowledge to develop the actual core piece of such predictive maintenance systems.

In principle these new market participants should be welcomed because they promote the diversity and competition which is always beneficial to the products and services, the end customers and therefore the entire market. It is important that the established market participants, too, meet the new challenges. The technical development can never be stopped and without it elevators would never have been developed. All industries occupied with the maintenance of machines and therefore also the elevator construction branch are facing the next development step. And probably only those companies will survive which are ready to let themselves in for this step.

Jobs and digitization in elevator construction

In many places the digitization is threatening jobs. But this is currently not the case in the elevator construction industry. To anticipate the answer to the question put in the title: no, the service engineer will definitely not become a leftover and the new systems will not give rise to layoffs. A functioning predictive maintenance will rather be an appropriate means to counter

A digitization of lift systems cannot succeed without the domain knowledge of lift experts – this benefit of market participants must be used target-orientated. *(Pictorial source Henning)*

the lack of skilled labour in the elevator industry. Instead of job cuts it will be possible to service the increasing number of elevator systems without risking a growing number of system shutdowns.

In order to be a successful market participant in the years to come, it is necessary to occupy yourself with the new maintenance strategies and take a clear stand. The corporate groups of the elevator industry and some small to medium-sized companies, too, are preparing themselves for years and already successfully adopt initial solutions.

Service Broker – or how do you call it?

For the time being the number of jobs is not at risk. But this is not the case for many employers (small to medium-sized companies in particular) of the elevator branch and therefore also for the attractiveness of the highly qualified jobs and their remuneration. New business models are just establishing themselves on the market. They offer to the operator the service and maintenance (sometimes even including the operator liability). But the contractual service is not directly rendered. Instead it is subcontracted in an IoT-supported manner to subcontractors (sometimes to 1-man subcontractors). If this is thought out further, it may in the end lead to a splitting of the maintenance and service work in mini jobs (e.g. „Replace the guide shoe inserts“). As soon as the IoT unit has marked this job as “due to be dealt with”, every subcontractor can submit to the agent his offer for this particular job and will (presumably based on the price) be „chosen“ or not. This is irrelevant for the operator (e.g. the property manager) because he has ensured that the elevator is safe and available at a favourable price. It remains to be seen if this will be the case in the long term.

One (interface, cloud ...) for all!

Just like in the automobile industry, the elevator industry follows the trend that the component suppliers have to apply more and more parts of the special elevator knowledge. In small to medium-sized companies in particular the day-to-day routine business opposes the occupation with the constantly growing complexity of the elevator system and components and the increasing number of rules, regulations and standards. The vast majority of component manufacturers allows this knowledge to be incorporated into the digitization of the components. The resulting „smart“ components are already on the market but they are so

The usefulness of lift digitization is only fully developed when the results and data from the different components merge into a digital “elevator twin”. Common protocols and interfaces are indispensable to achieve this.. *(Henning)* seldom used that they can really develop their potential and therefore offer to the maintenance companies the „elevator 4.0“ or the „elevator service 4.0“.

A major obstacle is the missing standardization. Who is willing to install an individual router together with an individual SIM card for every elevator component and then click through dozens of different clouds and in the end find out that all components of this elevator system are in perfect working order and that there are no maintenance jobs due to be dealt with.

Without an open platform and/or open interfaces this is exactly the scenario to be expected, which will nip in the bud the digitization at least in the medium-sized elevator companies. And just like CANopen for Lifts was successfully developed a few years ago for the digital communication inside the elevator (developed substantially by German small to medium-sized companies), what is needed now is a solution for the communication to and from the elevator which is backed by a broad basis of market participants. All the more the protocols recently published in connection with „Smart Lift“ of the ETSI (European Institute for Telecommunication Standards) should be welcomed. The elevator market associations such as the VFA Interlift, too, toy with the idea to support the digitization efforts of their members with appropriate (cloud) solutions. All current market participants should have the common interest and grab the chance to co-operate and lead this project to success.

Digitization will fundamentally change the present elevator market. The risk is not so much a loss of jobs. But it might very well be possible that the present market mechanisms and business models will be subject to a lasting change. Market participants who are already occupied with the effects to be expected and who are working out or have already established long-term strategies up to new business models will remain to be most successful in the future.