THE CRITICAL IMPACT OF REMIANING USEFUL LIFE PREDICTABILITY OF FLEET MANAGEMENT AND MAINTENANCE

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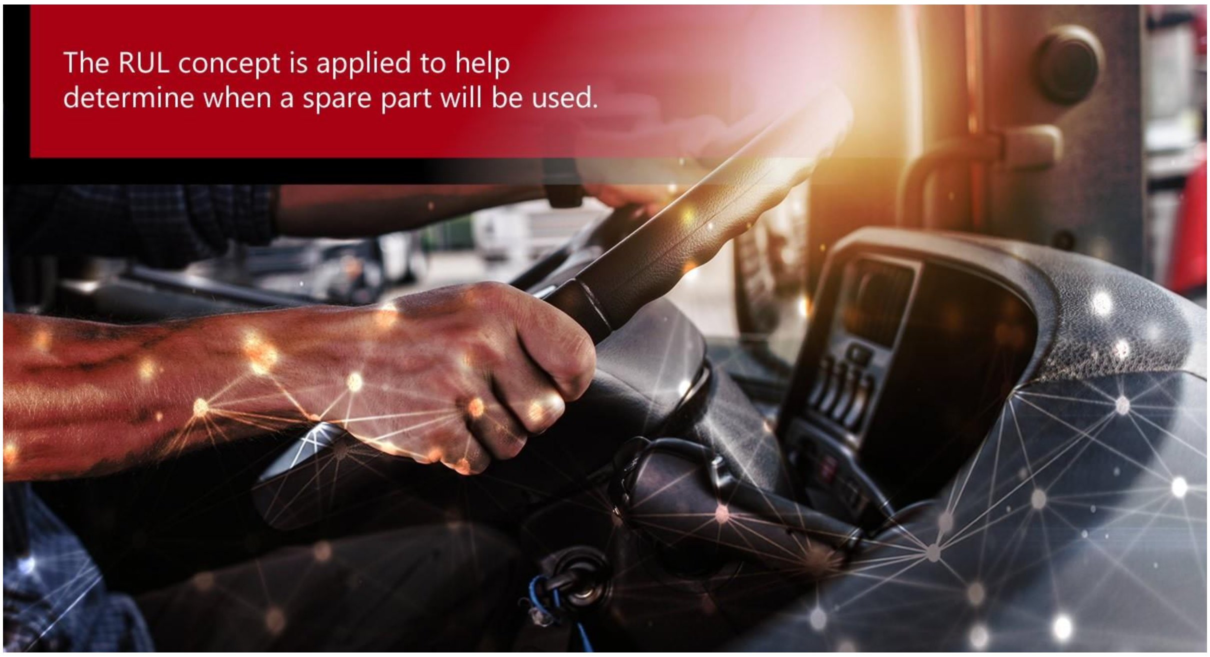
Has this ever happened to you? You purchased an item, you negotiated well on the price, you got a good deal and perhaps even a big discount - but then…you don't really use it.

It's a shame – not only because the item you purchased isn't being used, but the effort you invested in buying the item has also gone to waste. Unfortunately, this happens much more than you would expect.

In Fleet Management, usefulness and usability are critical factors in determining the value of an item. If an item – or spare parts – are not being used or are under-utilized, those spare parts are costing more than they should.

The concept of Remaining Useful Life (RUL) can be applied to an item's "usability". When applied to spare parts management, RUL can help solve the problem of lack of use or under-utilization, thus reducing costs and improving parts efficiency across an entire fleet of vehicles.



What is Remaining Useful Life?

The RUL concept is applied to help determine when a spare part will be used. To achieve this prediction, you need to know exactly how much wear is sustained by that part every time you use your machine/truck. You also need to know the impact of different types of usage on the wear.

Let's look at an example of a clutch on a truck, where the clutch manufacturer indicates that its clutch's life is 2 000 000 press on the pedal (such precise information is not usually available for most spare parts). However, the information provided by the manufacturer is not enough to truly understand the actual lifetime of the clutch. You also need to take into consideration whether the vehicle is used in city or highway driving conditions. If the vehicle is used more often in a city, the clutch is used much more often therefore its temperature will increase (temperature has an impact on the wear). You also need to know whether the gearbox is automatic or manual, since clutch usage will vary in each of these situations. Based on my experience, in average truck drivers will tend to save the clutch but few of them will break (while automatic gearboxes are set not to reach the breaking point).

Additionally, you also need to know the pressure on the clutch pedal. I have seen someone destroying a clutch in less than a day more than once. This was due to the driver leaving their foot on the clutch pedal while driving, which meant that there was a small amount of pressure on the clutch for the entire journey.

Therefore, to determine the RUL of a spare part, it's important to know and factor in several considerations:

· the basic wear information provided by the manufacturer,

· the specific usage (driver behaviour, mileage, weight…),

· the external conditions (external temperature, humidity …),

· vehicle sensor data (pressure on the pedal clutch (quantity and intensity), temperature, vibration …).

Once all this information is collected, it needs to be weighted. Weighting adjusts each factor according to various business and other rules such as cost, priority, etc. The result is a data algorithm which has taken all these factors into consideration.

Once an algorithm is in place, it's important to test the algorithm in a proof of concept phase. During this phase, real wear (vs predicted wear) can be measured on a vehicle and compared to the mathematical prediction. The algorithm can then be adjusted, replicating the past to predict future wear.

The result is a RUL prediction-: based on usage, external and internal conditions, it is now possible to predict the degree to which a spare part will be used. This means you will now know when a spare part will fail before it actually fails – and you can adjust your fleet management workshop schedule accordingly.

How can Remaining Useful Life change my organisation's fleet maintenance program and reduce costs ?

Let's look at two examples that explain the impact of RUL on a fleet maintenance program and a third example.

RUL Example 1: Battery Replacement

When I started in the heavy vehicle management business 20 years ago, we changed truck batteries every 4 to 5 years. In 2017, I made a decision to change the batteries for a part of the fleet I managed every 18 months. This was not because the quality of batteries was going down over 20 years, but because the driver's quality of life was going up.

20 years ago, the standard equipment in a truck cabin was an autonomous heating system (webasto), a radio and a few lights. A few years later, the phone appeared within the cabin – which at that time only needed to be charged once or twice a week. Then came the GPS system, the television with a satellite antenna, the fridge, the computer and, in the last 10 years, some drivers even have a microwave oven in the cabin plus an additional air-conditioning system for the night use when truck engine is off (on the top of the roof, or at the back of the cab).

The result of all these additional conveniences and features is a much greater need for electrical power. Batteries are therefore used much more frequently during the night, when the vehicle's engine is off, and the alternator cannot switch on. Additionally, the battery's power level varies much more frequently. As a result, batteries don't last as long.

How did we (fleet managers) react?

This shift in battery life has a direct impact on the number of vehicle breakdowns. To adjust to this shift, we gradually reduced step by step the life-time for the batteries in our maintenance program.

The cost of a truck battery is approximately 120 € not purchased in winter time, when batteries tend to more expensive (trucks require a set of 2 batteries). The cost of labour is near zero as it takes very little time to install a battery. The current average cost of a heavy vehicle breakdown on the road is approximately 1500 € if it happens on a French or German motorway.

Therefore, for every breakdown incurred, 7 sets of batteries could have been changed. If the number of breakdowns is more than 1 out of 7 trucks, you should reduce the mean time between changing 2 batteries. Usually, fleet managers don't wait to meet this ratio of 1 out of 7 because of additional costs incurred due to the breakdown such as penalties for the delayed delivery, extra hours to the driver and other costs (and customer satisfaction).

This is why I made the decision to gradually change batteries every 18 months for the long haulage trucks in my fleet.

However, this decision turned out to have flaws. Some of our drivers did not have microwave ovens, or did not use the air conditioning during the night, or preferred to read instead of watching TV. Unfortunately, the repair shop was unable to handle this level of detailed information even though it had a very real impact on battery use.

This is where RUL comes in and is highly successful at achieving savings. The RUL algorithm can determine when the battery will fail, based on the specific usage, for every truck. If a driver has a micro-wave oven or is using the air conditioning up to 19°, while another driver uses the micro-wave at a fuel station and sets the air conditioning at 22° during summer nights, the battery wear will be different in each circumstance. As a result, the Remaining Useful Life will be different as well. The RUL algorithm can recommend the repair shop to set its agenda so that truck A needs to change its battery in 24 months, truck B in 12 months and truck C in 50 months. Additionally, this prediction will automatically adjust when different drivers are allocated to different trucks.

To return to the original calculation where we purchased 120 € of batteries, you will now use 115 € of electrical capacity (we keep a safety buffer) thanks to the implementation of the RUL algorithm - and you won't face a 1500 € breakdown. The battery also won't be under-utilized – for example only using 60 € of electrical capacity, because the battery was changed too early – for example if the driver does not use it as much because the truck has been mainly used in Belgium where the climate does not require air conditioning to be used at full power compared to Croatia in summer.

It's clear from this example that Implementing RUL can deliver substantial savings in fleet maintenance and repair.

RUL Example 2: Tire Replacement

The second RUL example focuses on tyres.

When you purchase a truck tyre you have approx. 16 mm of gum plus 4 mm that you can regroove minus approximately 2 mm that cannot be used by law (1,6 mm in most countries). Therefore, when a tire is purchased, you are realistically purchasing a tire capacity of 18 mm. Depending on the tire model and your negotiation skills, the tire may be purchased for 300 to 400 €. The cost per 1 mm is approximately 20 € per tyre.

Now, if there are 6 tyres on a truck (european models), and the tyres are changed when 3 mm remain of tire wear instead of 2, this is a loss of 120 €.

(Believe me, 1 mm does not seem so big when you are in front of the tyre itself)

RUL can predict when the tyre must be changed, based on driver behaviour, temperature, weight in the lorry and other factors. It can also schedule the right moment to change the tire in the repair shop's calendar and educate technicians about the cost of 1 mm and the time it takes to be used.

RUL offers an effective approach for a customized yet efficient maintenance program for each vehicle in a fleet, based on that vehicle's specific usage. The result is maximizing the use of each spare part up to its maximum capacity without exceeding it.

RUL Example 3: Machine Spare Parts Replacement

One of Hitachi's customer is a machine manufacturer based in Europe. The main spare part in this client's machine must be changed every 3 to 6 weeks depending on the intensity of use and the way the operator drives the machine.

This client has customers of its machines in many countries around the world and would like to earn revenue by selling spare parts for its machines. However, it would be highly inefficient for the client to maintain a stock of spare parts all over the globe. Additionally, a customer based in South East of Asia or Australia would be more likely to prefer purchasing an adaptable (and likely cheaper) spare part from Asia than wait for spare parts to arrive from Europe.

To support the business goal of generating revenue from spare parts, we implemented an AI RUL algorithm. This algorithm is based on sensor data from the machine (e.g. temperature, vibration), on operator behaviour, on the machine load, and on external factors (such as weather). We can then predict when the spare part will have to be changed – and this is done remotely, 10 000 km away from the actual operational site.

The manufacturer can contact its customer and ship the spare part before failure. Another benefit is that the client no longer needs to call their customers every 3 weeks to see if spare parts are needed. In fact, when they do contact their customers, they are armed with valuable information about the intensity of spare parts usage. They can then share this critical information with their customers about their level of activity, thereby helping their customers reduce costs and increase the efficiency of their machines.

Which sales representative wouldn't love to have this level of information before calling a customer ?

Conclusion

There are many use cases for Remaining Useful Life in machinery, equipment, vehicle and most manufacturing environments where spare parts replacement is a necessity. If all the factors that determine the useful life of a spare part are not considered, the cost of spare parts management and replacement can be prohibitively expensive and even wasteful. RUL can be extremely effective in helping to reduce the cost of spare parts replacement by considering all the factors that have an impact on the remaining useful life of a part, and subsequently making predictions and recommendations based on those factors. The result is a significant reduction in costs associated with the maintenance and replacement of spare parts, improved efficiency, better fleet uptime and better overall outcomes.