How to 3x your COMPANY VALUATION?

Creating NEW DISRUPTIVE REVENUE STREAMS

sensorfy

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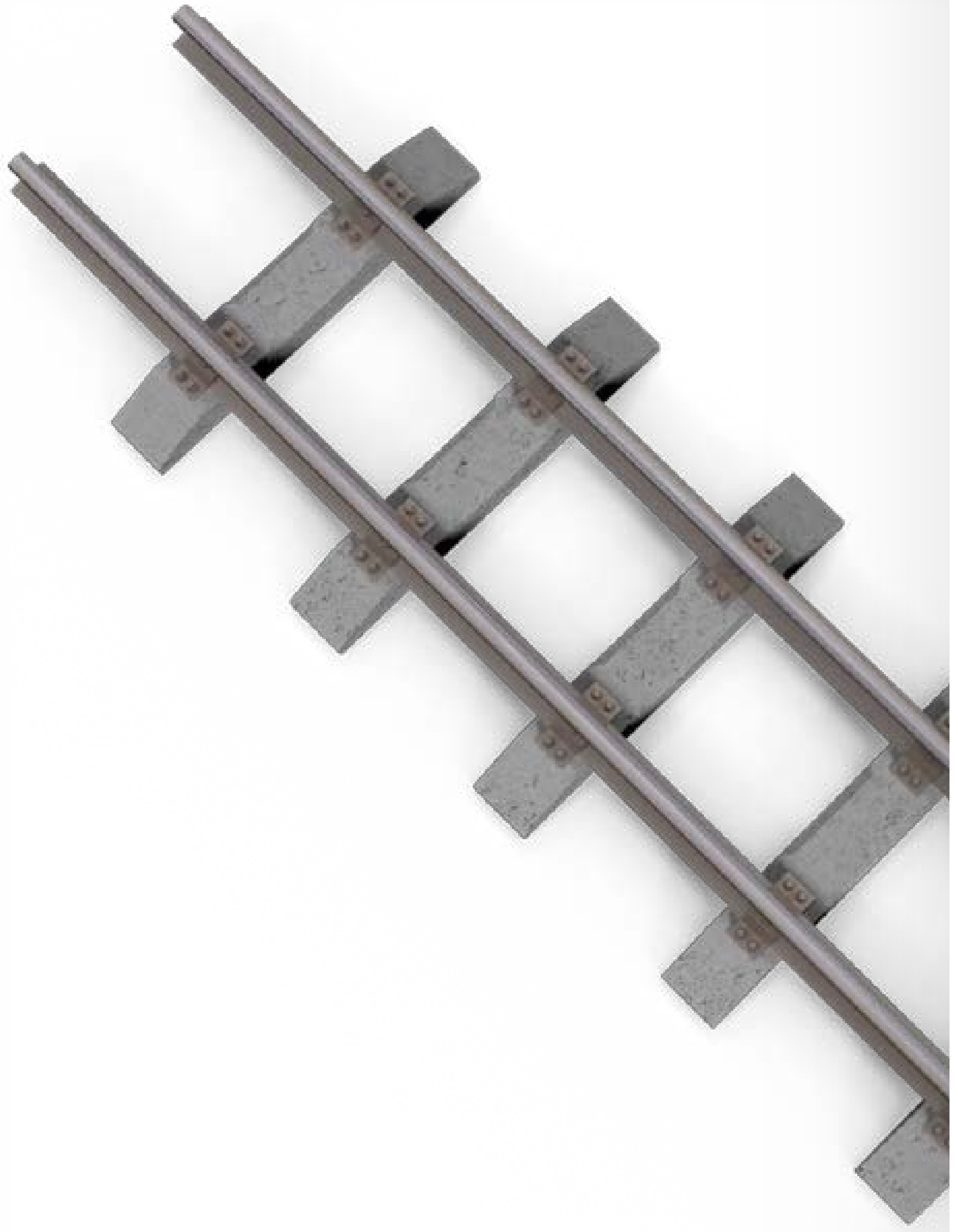
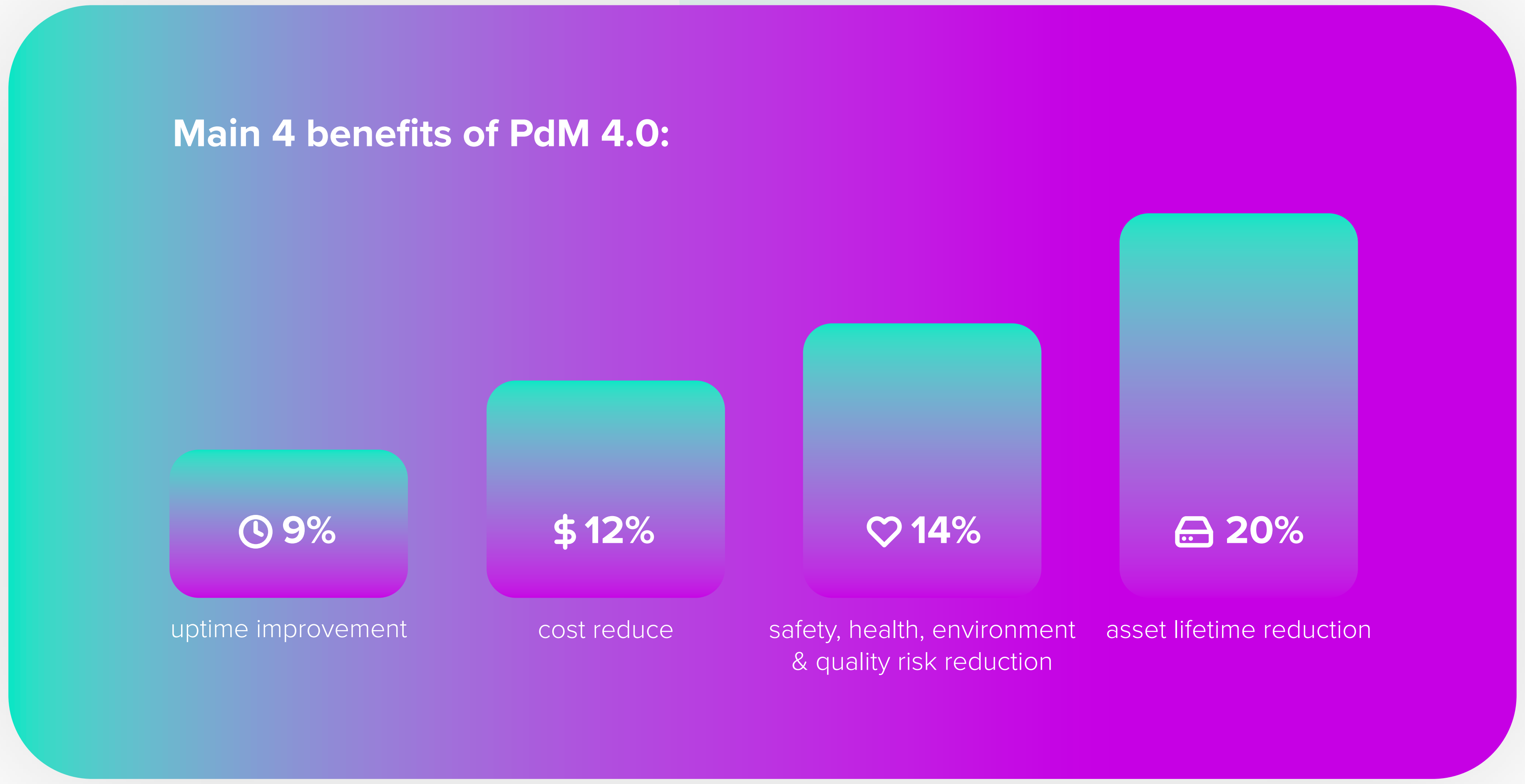


1. INTRODUCTION

Interest in predictive maintenance is growing rapidly in the industry thanks to advancing digitalization, the rise of the Internet of Things (IoT), and the rapid development of artificial intelligence (AI) technologies such as machine learning. Owners/operators of assets such as machines, mobile equipment, and installations are increasingly recognizing the great benefits that this form of maintenance can offer them. 'Predictive' means that maintenance is performed on time, based on predictions of imminent failures, before they actually occur. In this way, inconvenient and often expensive corrective maintenance, such as repair or replacement, is avoided, and planned maintenance can be deferred. As a result – and this is the real benefit of predictive maintenance – downtime is minimized.

PwC and Mainnovation have designated this type of smart/digital predictive maintenance as Predictive Maintenance 4.0 (PdM 4.0). Their 2018 survey revealed that over half of the responding asset owners were already implementing PdM 4.0 or were planning to do so. The same survey identified and quantified four main benefits of PdM 4.0: uptime improvement (by 9%), cost reduction (by 12%), safety, health, environmental & quality risk reduction (by 14%), and asset lifetime extension (by 20%)

The business case for predictive maintenance is therefore crystal clear to asset owners. However, to the original equipment manufacturers (OEMs) that have supplied the assets, the business case is less clear. In some cases, OEMs do not yet provide any service and maintenance, and if they do, they often still have a transactional business model. This conventional business model is based on revenue from incidental corrective maintenance, including the delivery of original spare parts. The aim of predictive maintenance is to eliminate this relatively expensive corrective maintenance as much as possible, and to replace it with cheaper interventions that can be planned more efficiently on the basis of predictions.



1. INTRODUCTION

Gijs Meuleman
Founder & CEO Sensorfy

The market is anticipating predictive maintenance eagerly, so OEMs cannot ignore this trend. A natural reflex is then to look for a solution in technology. OEMs equip their assets with all kinds of sensors to monitor the assets' condition, install an IoT solution to collect data, set up a (cloud-based) data analysis platform for predicting the maintenance that is required, and they are ready to get started. Technically it can be a great success, but the business result is often disappointing; because they have organized their predictive maintenance optimally, the revenue generated is lower than with the 'old-fashioned' corrective maintenance.

> **"The introduction of predictive maintenance does not start with the technology, but with the business model."**

The lesson to be learned from this is that the introduction of predictive maintenance does not start with the technology, but with the business model. In this guide, we will examine the various business models for maintenance, and demonstrate how an OEM can make the introduction of predictive maintenance a success through the transition to a suitable business model. It all starts with understanding how predictive maintenance can create value within the OEM's business context.

Enjoy reading this guide!

2.1 LIFECYCLE BUSINESS MODELS

Due to the increasing complexity of their technology and business, asset owners/operators are increasingly focusing on their core business. They organize their operation to be ‘lean & mean’, outsourcing supporting services and therefore divesting, for example, their technical service department. For service & maintenance of their assets, they rely on external parties. These can be dedicated service providers, but the OEMs which supplied the assets are natural partners of choice, because of their equipment expertise and their comprehensive offer of original parts. For an OEM, this means that the focus of its business model shifts from product to service.

As a consequence, the relationship between the OEM and the asset owner is no longer limited to the one-off purchase of an asset, but increasingly covers the entire lifecycle of the asset. Instead of a business model based only on product sales, the OEM will have to adopt a lifecycle business model including the delivery of services such as maintenance. This is a natural development, because over the years the OEM’s installed base is growing steadily, and service is increasing in its share of the business relative to new equipment sales. As this service business is maturing, an evolution of the OEM’s lifecycle business model is called for.

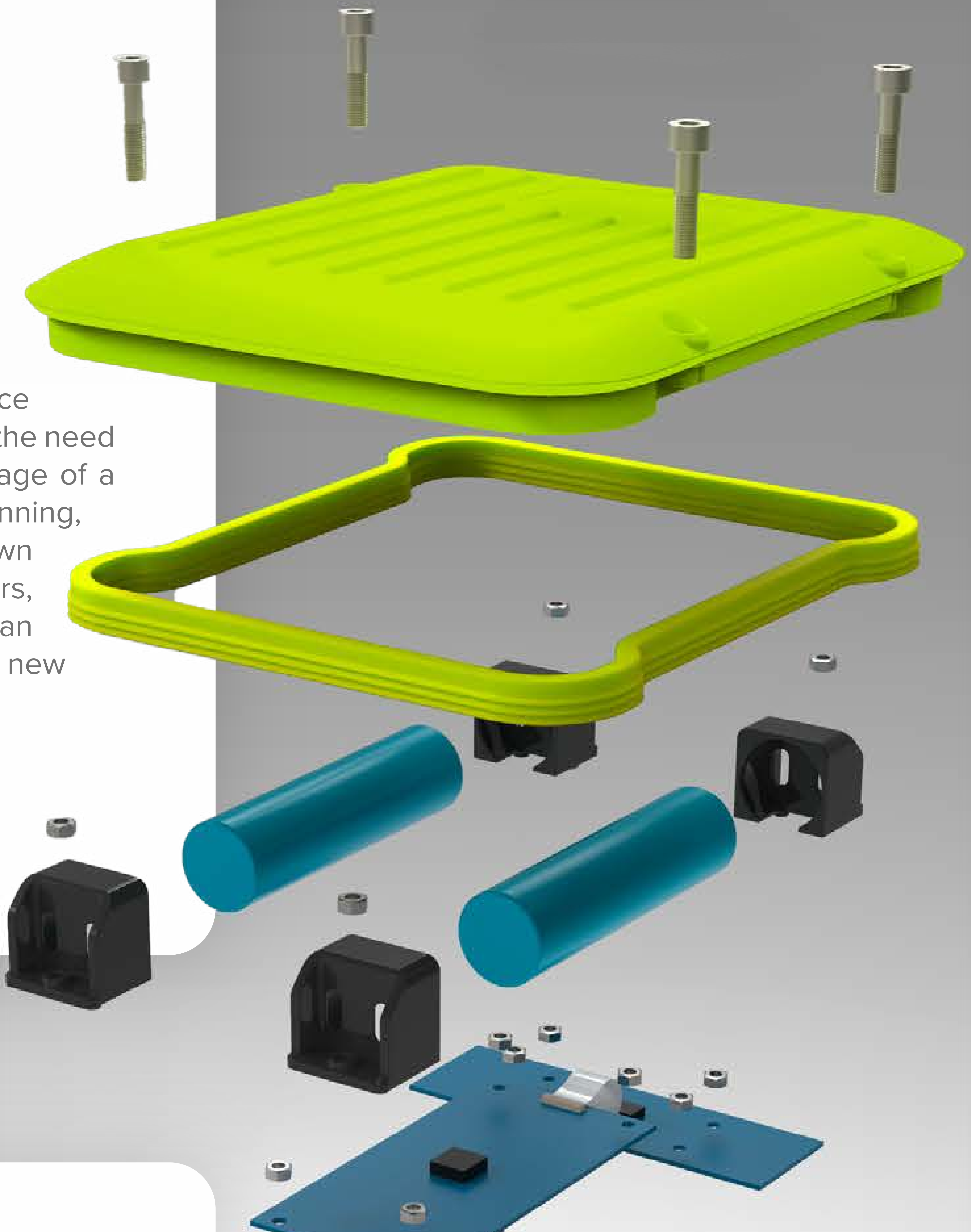
2.1.1
TRANSACTIONAL BUSINESS

The conventional service business model is of a transactional nature: asset owners operate their assets, and when malfunctioning or a breakdown occurs, or the need for maintenance is apparent, they call upon their service provider for corrective maintenance. In this model, the OEM can generate revenue from the deployment of service engineers and the sales of original spare parts. This revenue can be large, but is largely unpredictable, which makes capacity scheduling and spare part inventory management complex.

2.1.2

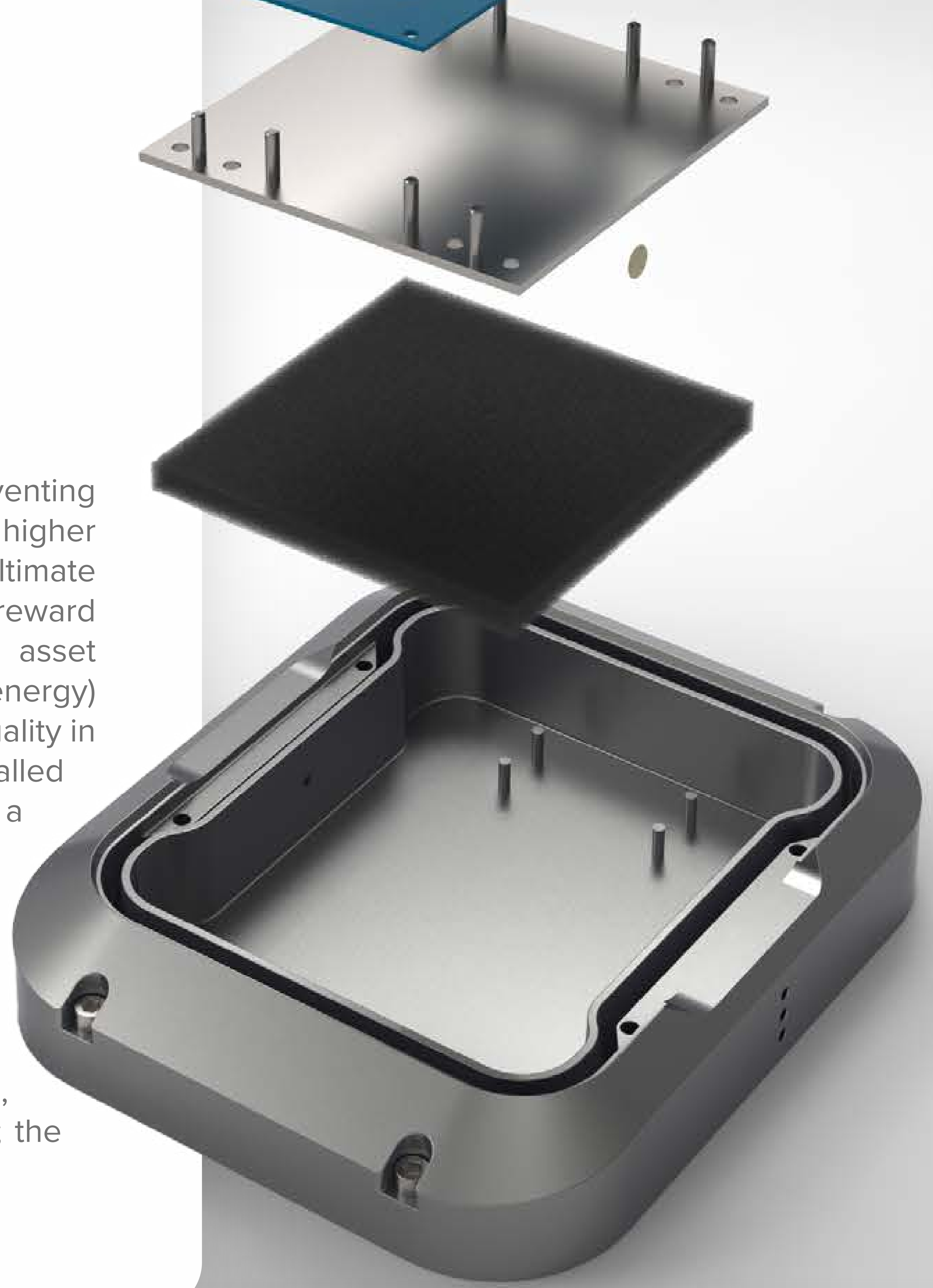
LONG-TERM SERVICE AGREEMENT (LTSA)

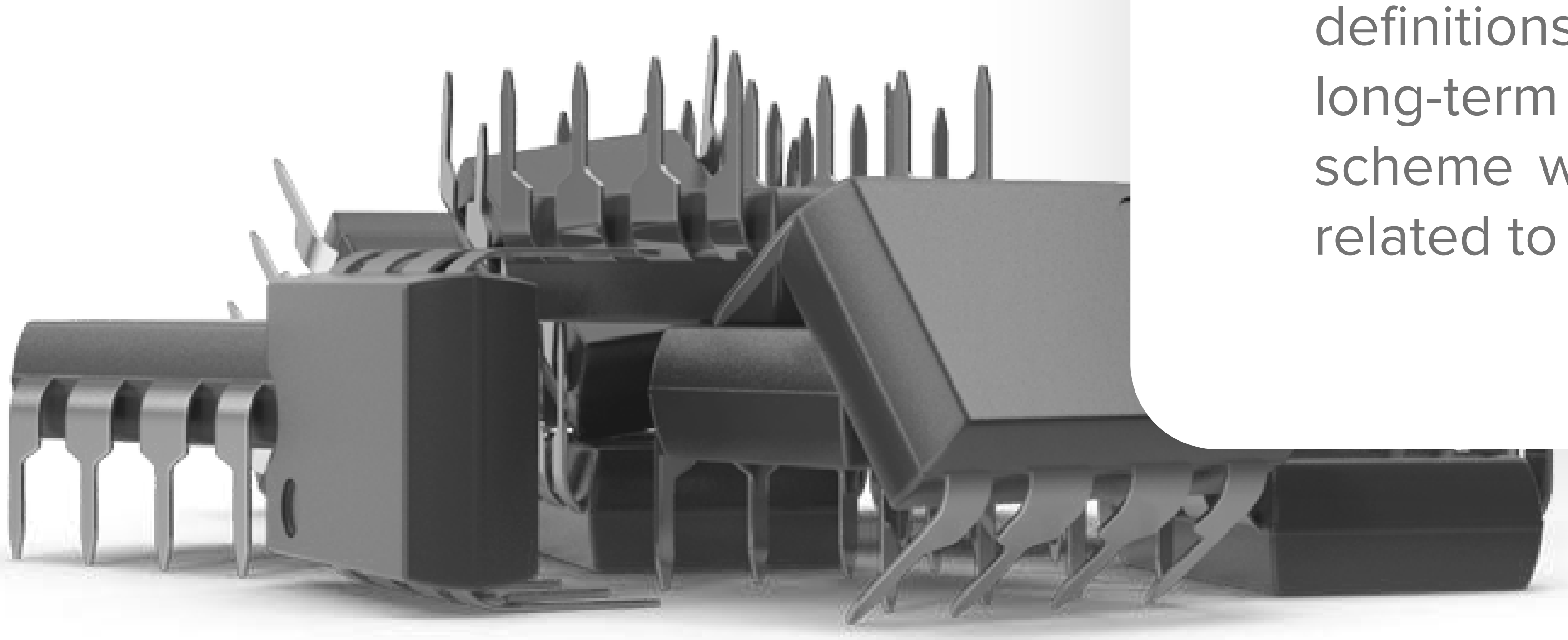
A lifecycle business model by nature covers the long term. Thus, it is logical to close a long-term service agreement (LTSA) for service business. This agreement will include planned maintenance to keep the asset in a good condition and reduce the need for corrective maintenance. This has the advantage of a more predictable revenue stream and work planning, which in turn helps the OEM to optimize its own service supply chain, comprising parts suppliers, subcontractors, etc. As a bonus, an LTSA can strengthen customer loyalty, which may provide new opportunities for product and services sales.



2.1.3
OUTCOME-BASED BUSINESS MODEL (OBBM)

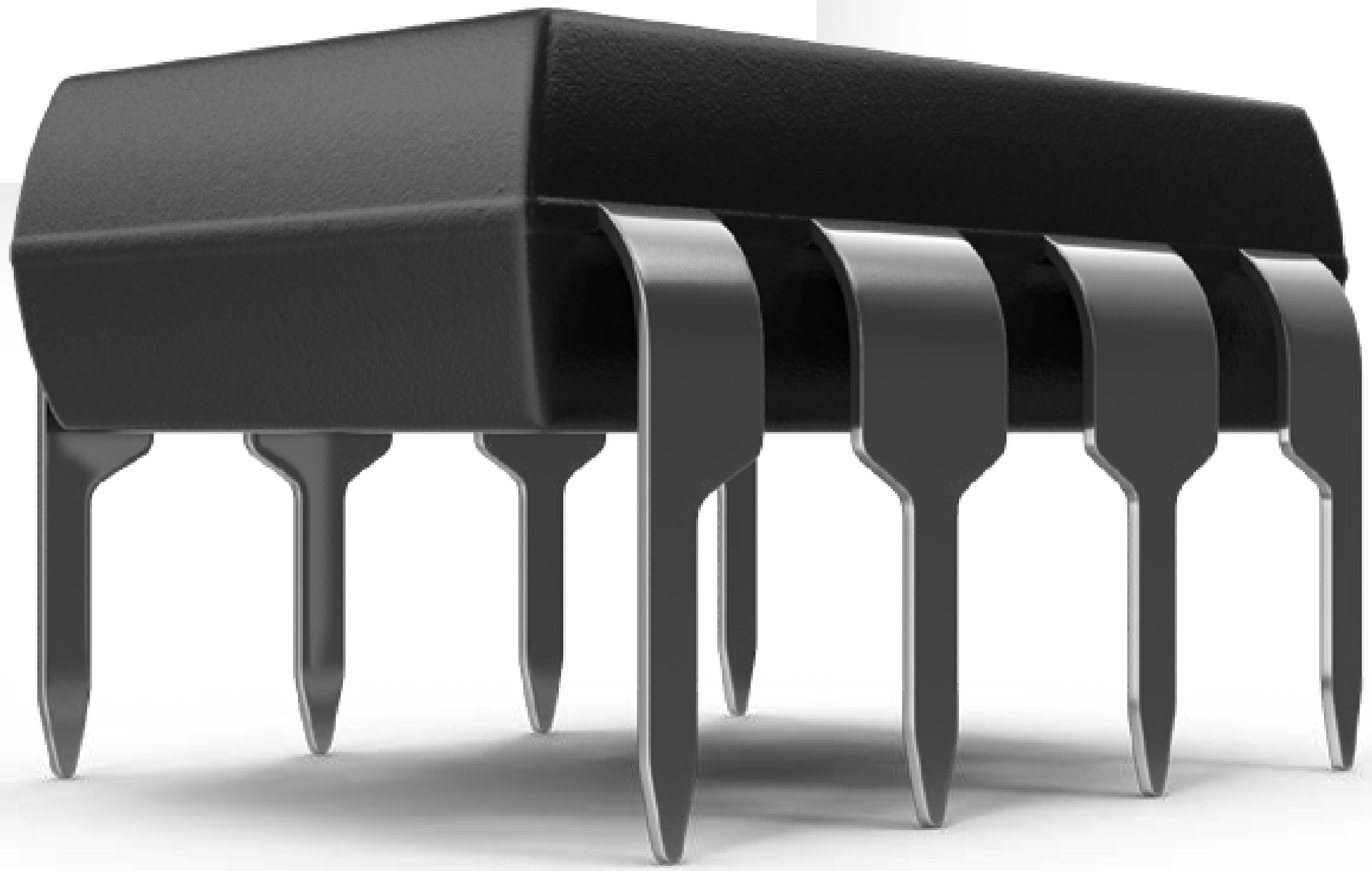
In the end, service is not about solving or preventing problems, but about creating a positive outcome: higher output, better quality, less downtime, etc. So, the ultimate service business model is outcome-based, and the reward is related to this outcome, as measured by asset performance in terms of operating hours, (energy) efficiency, or output (total number of products or quality in terms of ppm defects). As a first step, a so-called bonus/malus construction can be agreed upon: a baseline fee, to which a bonus is added if the outcome is above expectation, or from which a malus is subtracted when the performance is below par. This can be taken a step further by introducing pay-per-use: the asset owner does not pay for the asset, but for its performance. If the business model is 100 per cent outcome-based, there is no more product sales, just service sales; the asset is provided as ‘hardware as a service’.





2.1.3
HYBRID LTSA-OBBM

What has been described above is, for clarity, singular business models, with the suggestion of a chronology in their adoption. In practice, once an OEM has discarded a purely transactional model, it can integrate elements of both the LTSA and the OBBM approaches in its current business model. After all, it is only natural to include definitions and targets for the expected outcome in a long-term service agreement, and to provide the reward scheme with bonus/malus options related to this outcome.



2. TRANSITION TO PARTNERSHIP BUSINESS

2.2 TOWARD AN LTSA

A first logical step for an OEM that has a transactional model is to change the incidental nature of its service business into a structural business with a predictable cashflow. In order to close LTSAs with its customers, i.e. the asset owners/operators, the OEM must come up with good arguments. The great advantage of better plannability of maintenance applies to the OEM as well as to the asset owner. After all, maintenance interventions, from small preventive part replacements to major stops, can be planned efficiently, in terms of the asset owner's production capacity and the OEM's deployment of maintenance engineers.

If the costs of maintenance decrease in this way, of course the OEM can translate this into lower rates for the asset owner.

> **"The great advantage of better plannability of maintenance applies to the OEM and asset owner."**

However, this financial margin can be used alternatively to provide additional services, such as monitoring the performance and reliability of the asset. With modern communication technology, this can be done online, i.e. remotely, so that the costs remain limited. It is not usually necessary to offer a full predictive maintenance proposition from the onset. Often monitoring and real-time support in the case of issues – facilitated by data acquisition using an IoT network – is already a major step forward.

> **"The customer does not have to pay extra, yet it can already reap some benefits."**

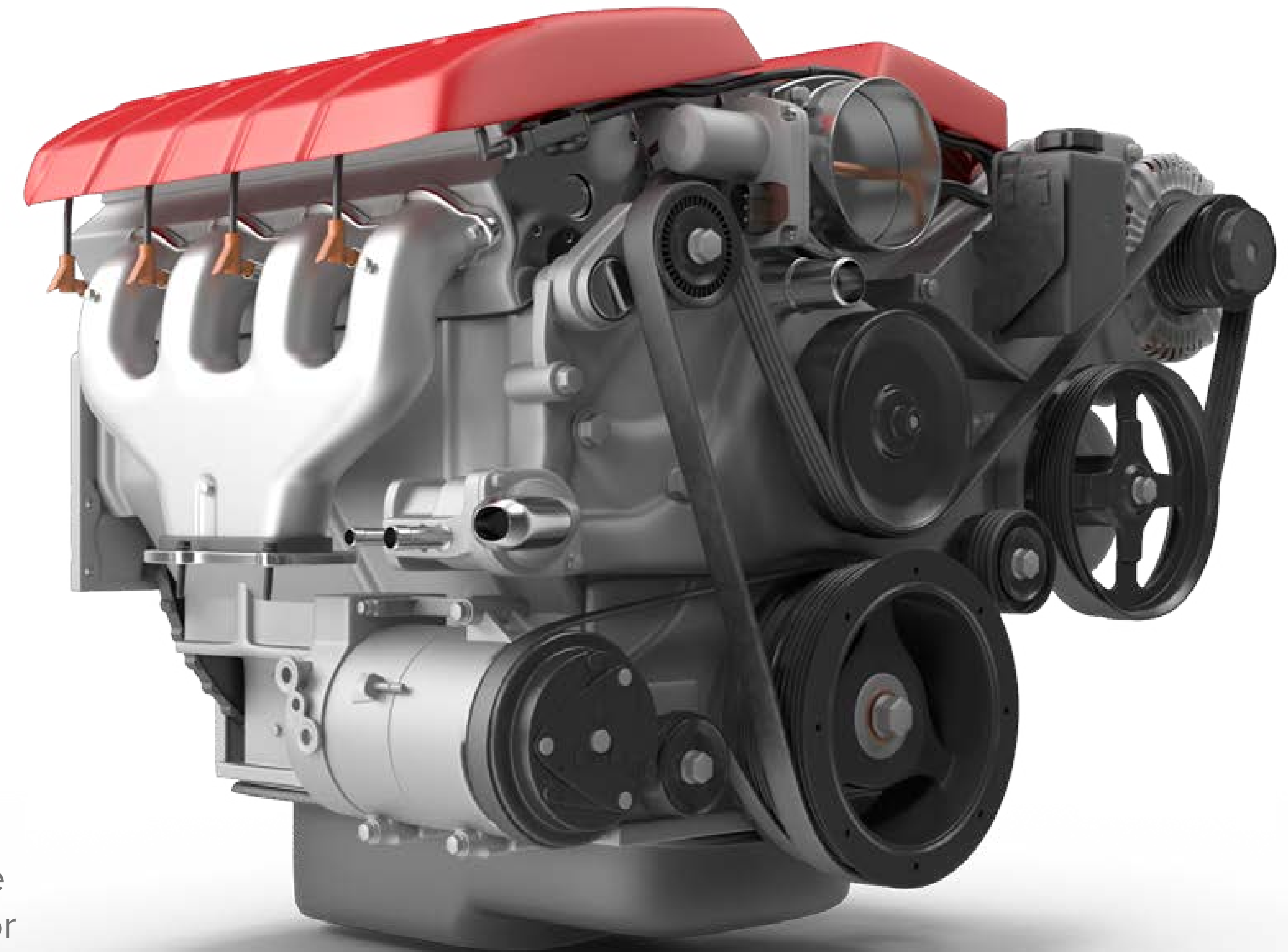
With this option – providing additional services instead of giving discounts on parts, for example – the customer does not have to pay extra, yet it can already reap some benefits from using new technology, while the OEM does not have to sacrifice revenue. Moreover, the OEM can familiarize its customers in a low-threshold manner with the use of this technology that, in the future, can also be applied for predictive maintenance, opening up new business possibilities for the OEM.

2.3 TOWARD AN OBBM

Once an asset owner has gained experience in monitoring its asset and processing the collected information, the step from insight to outcome – and possibly a transition to an OBBM – is easier to take. Predictive maintenance as an enabler for maximizing outcome is a natural facilitator for this transition. In this new business model, a reward scheme has to be defined that is not based on input (parts and hours), but on outcome.

Implementation starts with defining the lifecycle performance of an asset: what are the key performance indicators and which physical quantities must be measured for this? This translates into sensory requirements: quantities that can be measured or deduced directly from control settings (think of motor currents, etc.), and quantities that can only be derived from measurement by dedicated sensors. Ideally, these sensors have already been integrated into the asset at an earlier stage, to prevent iterative sensor updates (and corresponding investments) with each business model progression.

The key to a successful OBBM transition is the OEM's ability to enhance the performance of its equipment within the customer's business context. For example, the reliability/availability or the efficiency of the equipment needs to improve significantly. This requires data processing, an IoT network, and a (cloud-based) data analysis platform, including (AI-based) algorithms. Where applicable, these can be reused from the previous (LTSA) stage. Once again, the conclusion is that technology is required to facilitate a business model transition.



3. LIFECYCLE EARNING POTENTIAL

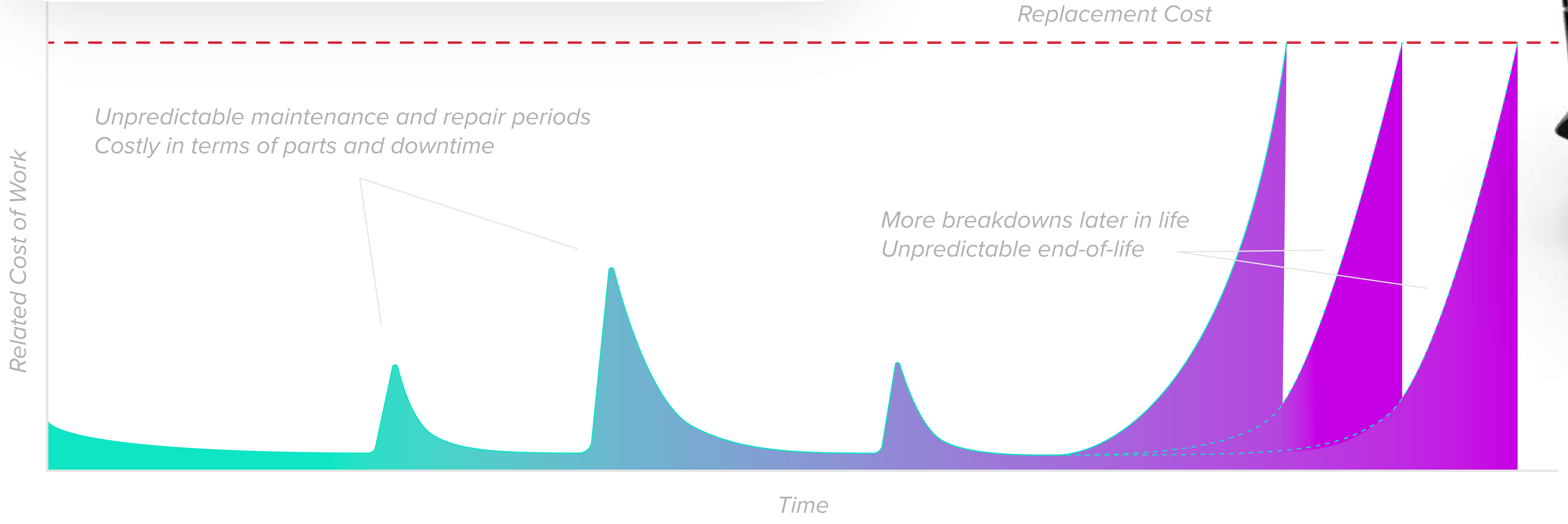
The consecutive transitions from a transactional business model to an LTSA to an OBBM correspond roughly to the evolution from corrective to planned to predictive maintenance. When deciding on a possible change of business model, it is important for an OEM to have a clear picture of the revenue stream.

This is because when maintenance is organized in a smarter, more efficient way while the financial relationship remains purely transactional, the OEM's revenue will only decrease, and the benefits will accrue exclusively to the asset owner. We will substantiate this using graphical representations (modified from a Datch blog) of the lifecycle earning potential of an asset for the various maintenance schemes, taking the perspective of the OEM providing service for this asset.

3. LIFECYCLE EARNING POTENTIAL

CORRECTIVE MAINTENANCE

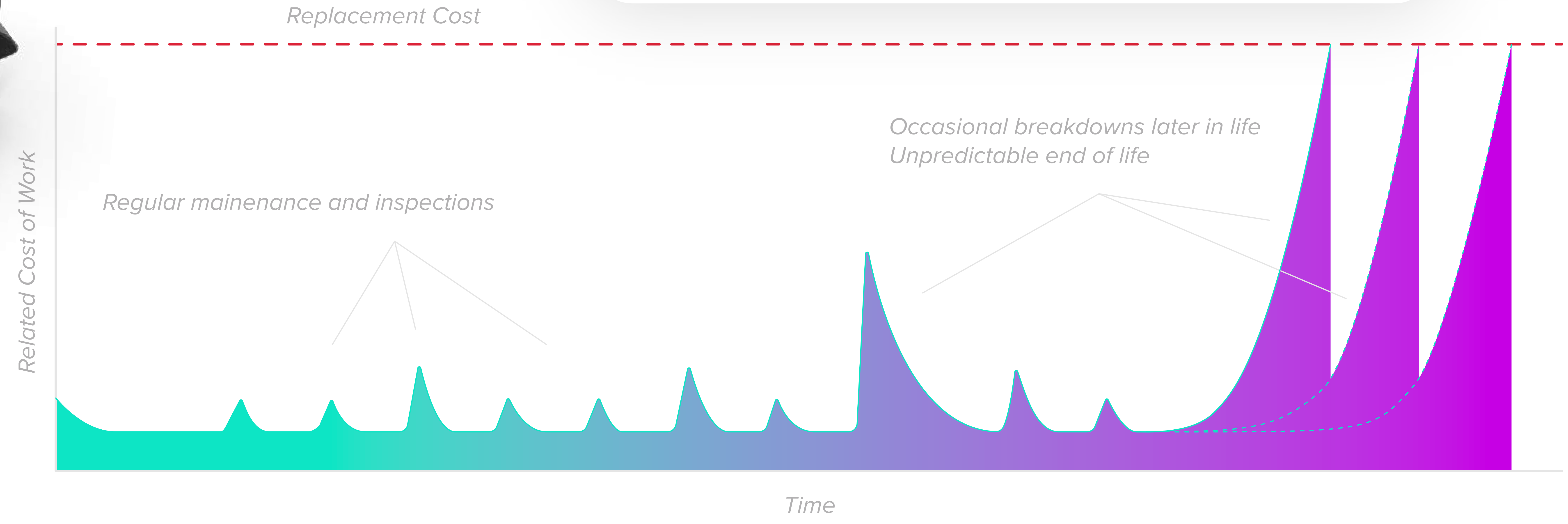
The conventional corrective maintenance approach involves irregular, often extensive, and therefore expensive actions, which will only increase toward the end of the – relatively short – lifetime. The total costs – derived from the total area under the cost vs. time graph – for the asset owner, and thus the revenue of the OEM, will be high.



3. LIFECYCLE EARNING POTENTIAL

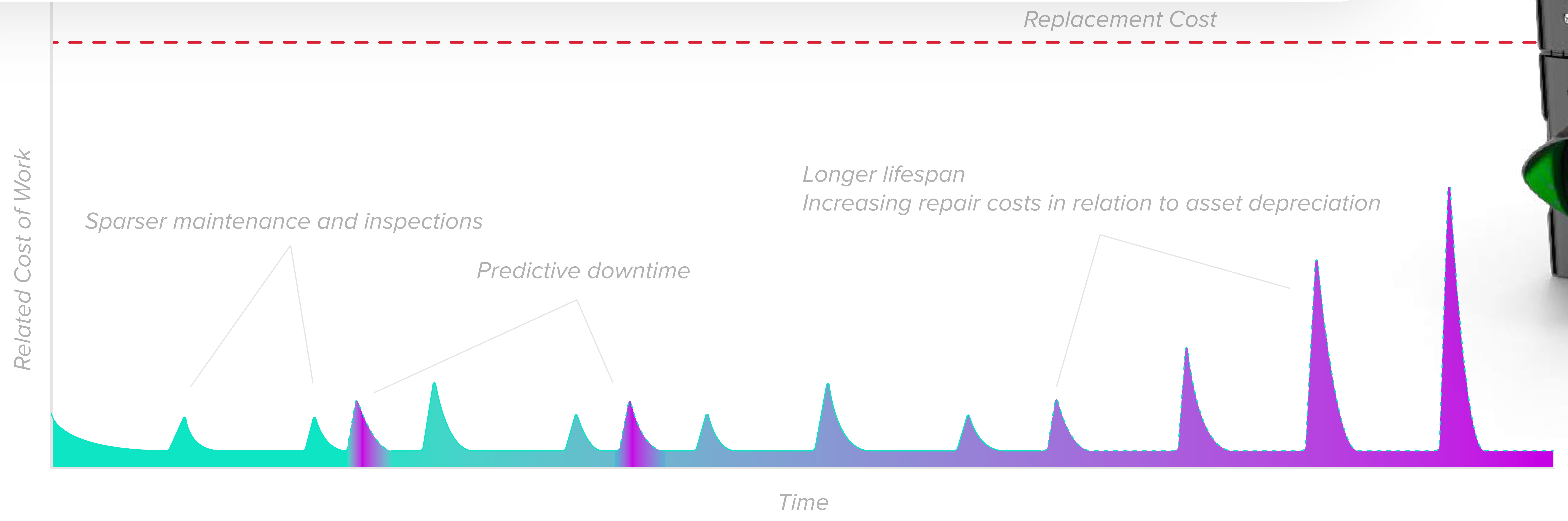
PLANNED MAINTENANCE

In the first years of the asset lifetime, planned maintenance mainly comprises regular, minor maintenance (inspection) actions. These will extend the asset's lifetime, but more corrective interventions will be necessary toward the end because not all malfunctions will be prevented, as there is no detection mechanism in place. Total costs/revenue will still be high.



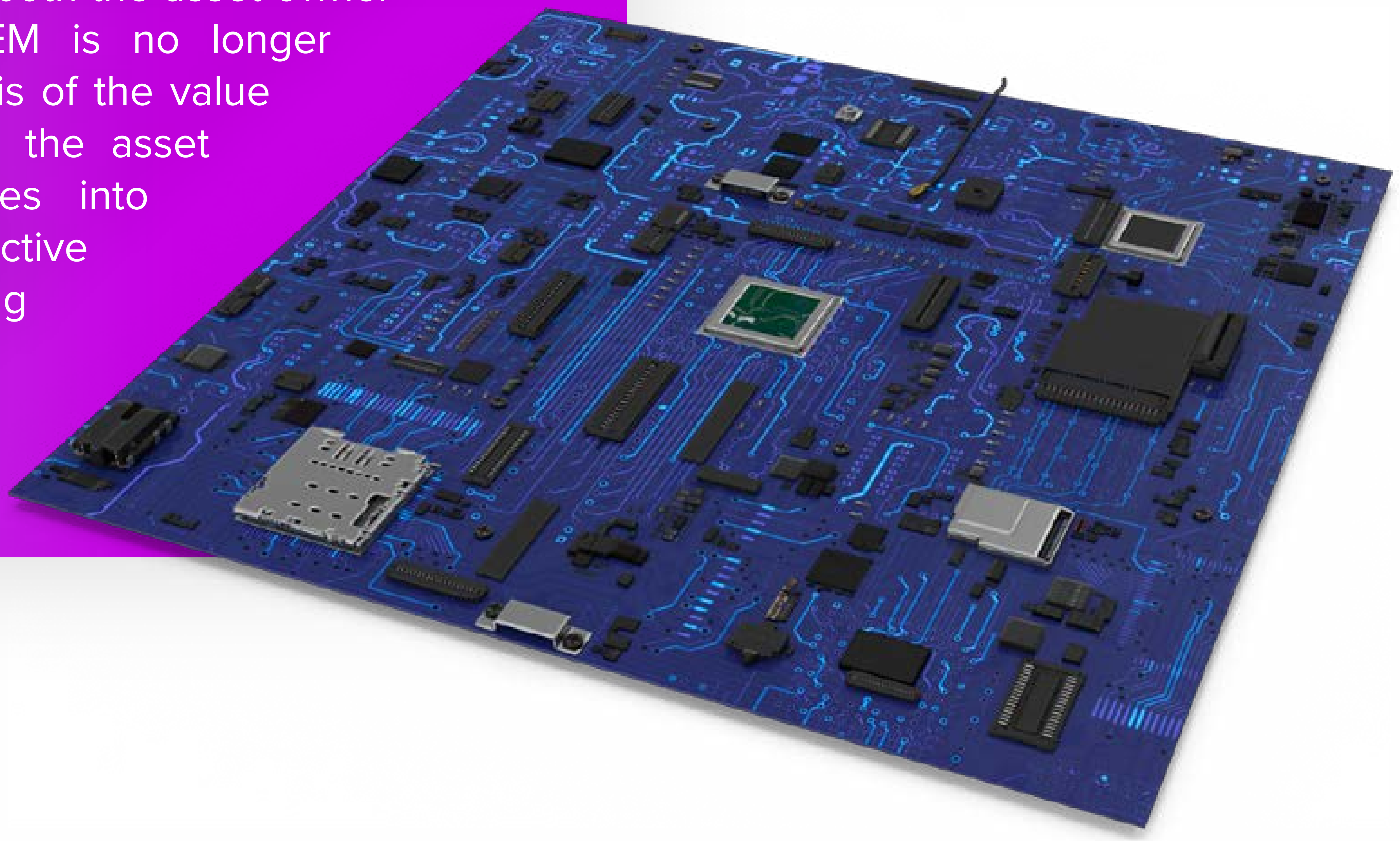
PREDICTIVE MAINTENANCE

In addition to planned downtime, predictive maintenance includes irregular maintenance actions that arise from predictions based on condition monitoring that indicates imminent malfunctioning. All these interventions are relatively cheap, because they take place on time, before (major) damage can occur due to malfunction or failure. While the total lifetime of the asset will be considerably extended by this maintenance strategy, the total costs for maintenance decrease considerably. Inevitably, in the final stages of the asset's lifetime, the advanced age will take its toll in the form of more repairs. Using the maintenance and condition history of the asset, an optimal end-of-life will have to be determined.



3. LIFECYCLE EARNING POTENTIAL

If the financial relationship between the OEM and the asset owner has remained strictly transactional, then the revenue for the OEM will diminish. The benefits of predictive maintenance for the asset owner are clear: less downtime and a longer lifetime. In an OBBM, this can be transformed into a win-win situation for both the asset owner and the OEM. The reward for the OEM is no longer determined transactionally, but on the basis of the value that its predictive maintenance offers to the asset owner. Cost-based pricing then changes into value-based pricing. In the end, predictive maintenance is not so much about solving problems as it is about investing in the reliability and availability of the asset.



4. PREDICTIVE MAINTENANCE PROPOSITIONS

We have shown that under market pressure and the influence of emerging digitalization (IoT, AI), an evolution of maintenance strategies can take place. This calls for a business model transformation, should the service-providing OEM wish to maintain its revenue flow. After an intermezzo with figures about data-driven predictive maintenance, we will present two concrete predictive maintenance propositions, both based on downtime reduction, that OEMs can offer to asset owners/operators. To conclude, the Caterpillar case will demonstrate the potential of digitalization and big data for business model innovation in asset management and maintenance.

INTERMEZZO: DATA-DRIVEN PREDICTIVE MAINTENANCE

Predictive maintenance based on big data has been defined as Predictive Maintenance 4.0, in analogy with Industry 4.0, the fourth industrial revolution, driven by digitalization and big data. A survey of 268 Belgian, Dutch, and German companies, primarily asset owners, (PwC & Mainnovation, "Predictive Maintenance 4.0," 2017) revealed insights into the primary goals and critical success factors for adopting predictive maintenance, as well as in the types of data used.

The survey (see below) clearly revealed that uptime improvement, or conversely downtime reduction, was the main driver for adopting predictive maintenance, with cost reduction, for example, a "mere side effect." Naturally, budget and technology (and culture, i.e. people) were among the critical success factors, but the most important one was the availability of all sorts of data. Ranging from the maintenance history of an asset to its usage and condition, and to environmental data, the important questions are which specific data should be collected, which data acquisition technology used, and which protocols followed? Data security was already a big issue in this survey, and in the time since the survey was conducted the increasing number of data security breaches may have further aggravated concerns about this matter.

4. PREDICTIVE MAINTENANCE PROPOSITIONS

PRIMARY GOAL

Uptime	51%
Customer	12%
Cost	11%
SHEQ	8%
Lifetime	7%

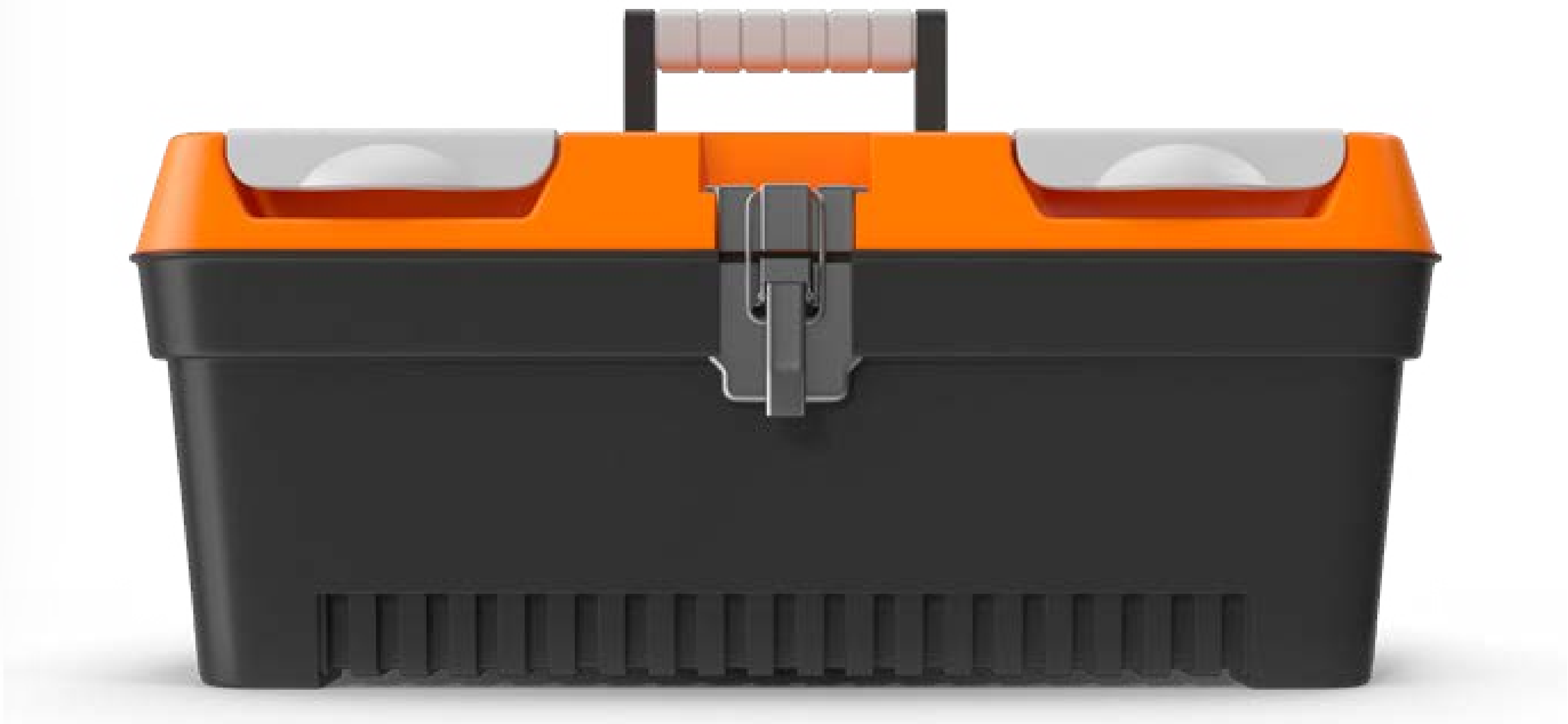
Uptime improvement / Customer satisfaction improvement / Cost reduction / Safety, health, environment & quality risk reduction / Lifetime extension of aging asset

CRITICAL SUCCESS FACTORS

Availability of data	67%
Budget	60%
Technology	59%
Data security	43%
Culture	35%

TYPES OF DATA

Condition of the asset	87%
Maintenance history	84%
Usage of the asset	83%
Data of other assets	51%
Enviromental data	44%



4.1 ELIMINATING UNPLANNED DOWNTIME

One of the biggest challenges for asset owners/operators is unplanned downtime. Malfunctioning or downright failure of equipment can cause costly repairs, and also comes with productivity loss. Asset operators are prepared to invest in certainty of operation, so they turn toward solutions such as condition monitoring. This not only enables the early detection of potential failures to prevent damage, but can also assist in real-time remote troubleshooting to resolve any issues quickly.

A specific application of predictive maintenance technology that can contribute to unplanned downtime reduction is anomaly detection. This concerns quantities such as temperature, pressure, flow, and vibration levels.

> **"The model yields its predictions based on either engineering rules or "AI rules," i.e. machine learning."**

Anomalies can be identified by comparing the predicted value of the quantity involved as provided by a model to the actual value measured by one or more sensors installed in the asset. The model yields its predictions based on either engineering rules or "AI rules," i.e. machine learning. In general, expert judgement is still required to assess whether a detected anomaly is real or just an artefact, for example due to sensor malfunctioning.

Anomaly detection: a Wärtsilä case

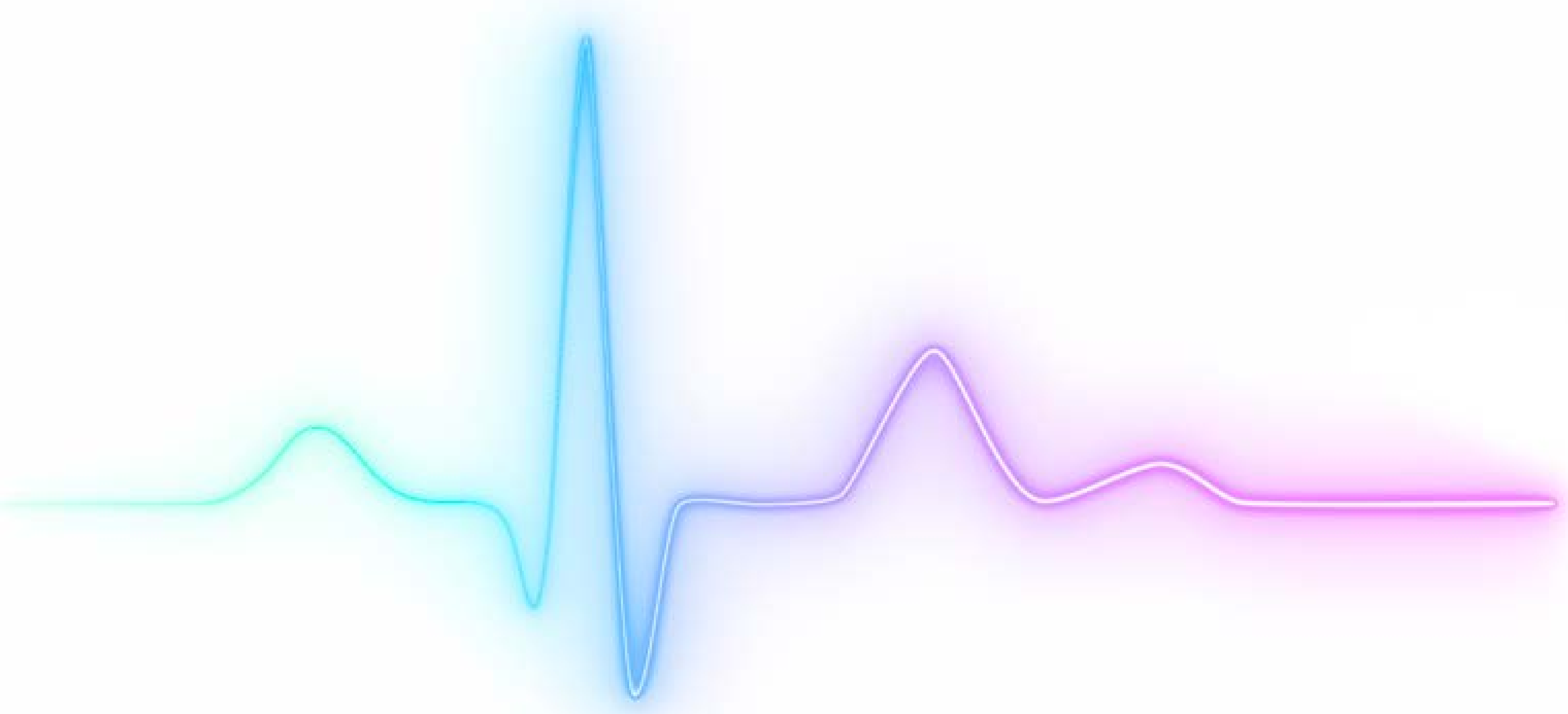
Wärtsilä is a global leader in smart technologies and complete lifecycle solutions for the marine and energy market. In this case, Wärtsilä dual-fuel engines on a tanker were monitored using Wärtsilä Expert Insight, a predictive maintenance service that combines AI techniques and advanced diagnostics with Wärtsilä's OEM expertise to identify anomalous behavior. This service detected a potential problem with the lube oil pressure in one of the engines. The remote diagnostics expert at hand decided that this was worth investigating, and when on-board checks revealed the cause, the engine had to be taken offline. A service engineer was brought on board to perform the repair before the tanker was due to reach its destination, where it needed all its engines available for dynamic positioning. Had the engine not been back up and running in time, this would have led to significant financial and operational consequences for the vessel owner.

4.2 OPTIMIZING PLANNED MAINTENANCE

In addition to preventing unplanned downtime, there is also much to gain from optimizing planned downtime. Maintenance planning can be made smarter by eliminating premature interventions without compromising asset reliability. This is possible, for example, by scheduling the replacement of failure-prone components based not on the average expected lifetime, but on predictions of the actual lifetime of the specific components. If these predictions are of good quality, replacing components will be performed at the “right” time, i.e. not too early (making well-functioning parts obsolete and unjustifiably shortening maintenance intervals), or too late (leading to potential failure).

> **“By observing the pattern of degradation, a prediction can be made for the remaining useful lifetime.”**

This calls for high-quality predictions of the “remaining useful lifetime,” based on condition monitoring of the quantity or quantities involved, to detect any trends that are indicative of an approaching end-of-life. By observing the pattern of degradation, a prediction can be made for the remaining useful lifetime. By using this estimated remaining useful lifetime – which should include a safety margin – the replacement can be planned.



4.3 A COMPREHENSIVE OFFER: THE CATERPILLAR CASE

Caterpillar, a world-leading manufacturer of construction and mining equipment, engines, turbines, and electric locomotives, has developed a suite of Cat® MineStar™ solutions for its mining equipment business. These solutions offer a wide variety of functionalities to track, monitor, automate, and manage all types of assets. The overarching goal is to help Caterpillar's customers, the asset operators and owners, to run a safer, more productive, and more efficient operation

For example, Caterpillar Fleet analyzes operational and equipment data in the customer's value chain to optimize equipment scheduling, material movement, and fuel use. The Detect solution helps to increase work safety, among other things, by providing visibility to the immediate environment around manned or remotely controlled (mobile or fixed) equipment, in order to eliminate blind spots, identify fatigued operators, or alert them to potential collisions.

The Health solution helps asset operators/owners to better analyze their equipment and predict service needs, in order to maximize availability and reliability. This solution monitors critical machine parameters, collects real-time alerts, analyzes operational trends and patterns, predicts failures, and presents repair recommendations, thereby enabling predictive maintenance. And there are even more solutions.

> **"The Detect solution helps to increase work safety, by providing visability to theimmediate environment."**

The Minestar™ interface can integrate differently branded products and mine management systems, and equipment from other manufacturers to define a new business model architecture aimed at creating value and, ultimately, optimizing the operation of a complete mine site. Based on this new architecture, different mine-specific business models can be built. Caterpillar's objective with developing MineStar™ was not to reduce complexity in operating mining equipment, but to exploit the potential of digitalization and big data for business model innovation.

5. CONCLUSION

Predictive maintenance is on the rise in the industry, thanks to its business case promising asset owners efficiency improvement and downtime reduction. For OEMs, however, the business case is not so straightforward, because in their traditional – transactional – business the revenue from service will decrease when offering predictive maintenance. Hence, OEMs have to move over to partnership-based business models, such as long-term service agreements and, eventually, outcome-based models. Only then can they capitalize on the lifecycle earning potential of maintenance, moving forward from corrective to planned to predictive schemes.

So, the introduction of predictive maintenance starts with business model innovation. This is then facilitated by technological innovation, covering digitalization, IoT, and AI. To facilitate the adoption of predictive maintenance business and technology, a gradual approach is recommended. This will start with well-defined, limited predictive maintenance propositions that OEMs can offer to asset owners/operators. For inspiration, however, it is vital to keep an eye on the bigger picture of a new (digital) business model architecture aimed at creating value and optimizing asset operation by means of predictive maintenance.

Interested in talking business? As a professional solution provider, Sensorfy is ready to support your business model transformation toward predictive maintenance with digital, IoT, and AI technologies.

6.
ABOUT THE AUTHORS

6. ABOUT THE AUTHORS

Frank Velthuis, co-author of this guide, specializes in performance optimization of assets through digital as-a-service products. Thus, enabling a profitable lifecycle business for industrial companies. He has a passion for creating customer value with asset management technology.

Frank has developed several digital products for predictive maintenance and performance optimization. Such as Expert Insight, OPERIM and PCMS at Wärtsilä, a large OEM and service provider active in marine and energy markets. He recently started as Director Digital Service Development at Vanderlande, a leading supplier of future-proof logistic process automation at airports, warehouses and in the parcel market.

He is also a module leader in predictive maintenance at the Master of Engineering at the HU University of Applied Sciences. This is a 2.5-year program for engineers who seek to better understand asset management, and asset performance optimization, and how to implement these practices and technologies within their business context.

“ In the past 10-15 years developing digital products has changed from building own data collection systems, and sending data over FTP, towards off-the-shelf IoT edge systems. And from implementing engineering and design rules towards applying machine learning and AI. Although it has never been easier to develop digital products, experience remains key. Using the right technologies in the right way makes sure you get the most value at a reasonable cost. When you start your digitalization journey, or if you are about to enter a next chapter, be sure to partner up. ”

Frank Velthuis
Director Digital Service Development Vanderlande

6. ABOUT THE AUTHORS

Gijs Meuleman
Founder & CEO Sensorfy

Sensorfy isn’t just a leading industry 4.0 innovator – we’re a family of talented, hard-working professionals dedicated to empower change with technology. By producing the most accurate smart sensors and analytics, we help industrial companies to eliminate unplanned downtime and lengthen the lifetime of their assets. Customers can achieve a 12% cost reduction. Together we make industrial operations more effective and sustainable.

Interested in making your machines ready for predictive maintenance? Want to know more about predictive maintenance, our sensors and technology or do you have other questions? Feel free to contact us!

Have a sensorable day,

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We empower forward-thinking industrials

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