White Paper

Augmented Reality Remote Service

A Study into 25 German Capital Goods Manufacturers

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Management Summary – Highlights of the Study

Effective and efficient service delivery in capital goods industries is essential in order to meet constantly rising customer expectations.

Even prior to the Covid-19 pandemic, there were many reasons to implement AR remote technology. The complexity and variety of the installed base often requires collaborative troubleshooting by interdisciplinary teams. Many companies complain about ever longer training periods for new service technicians due to decreasing qualifications and companies of all sizes struggle with the necessary service competence in foreign markets. AR remote services are one tool that can be used to meet these challenges.

The APPRISE research group at the Frankfurt University of Applied Sciences has collaborated with 25 capital goods manufacturers that have tested and implemented AR remote technology. The findings of this study were derived from interviews and workshops with strategically and operationally responsible managers and users of AR remote technology, namely remote experts and service technicians.

Use cases of the AR remote technology

- Differentiating characteristics for use cases include the type, intensity, and direction of knowledge transfer as well as the devices used since the benefits and challenges of implementation depend on these characteristics.
- Essentially, most existing service products can be improved by AR remote technology. Innovative new service offerings such as remote commissioning and remote pre-acceptance can also be developed.

Configuration of the AR remote technology

- When choosing technology suppliers, the focus should be on AR remote software rather than AR devices because the functional scope of the technology is more strongly determined by the software. Additionally, not many smart glasses are suitable for industrial use in the service business at this time.
- If smart glasses are to be used in support of industrial service delivery, they should be monocular.
- Most companies conclude that monocular smart glasses are ready for use in industrial service although there is potential for improvement in terms of battery runtimes, operability, display size, and comfort for the wearer.
- It is important to note that smart glasses are not always the best choice. Whether smartphones/tablets or smart glasses are more suitable depends on the specific use case. The advantages of one device are the disadvantages of the other.

Benefits & opportunities of AR-based service delivery

- AR remote technology enables the improvement of multiple service KPIs such as mean time of service intervention, remote troubleshooting rate, first-time fix rate of service technicians, and productive and/or chargeable hours.
- Potential for efficiency and effectiveness in the service organisation leads to monetisable value for customers in the form of either innovative service products or process innovation of the existing field service offerings, which can accordingly be priced higher.
- AR remote technologies open up new strategic opportunities such as independence from third-party service providers, potential exploitation of new customer groups, and expansion into less penetrated markets.

Barriers & risks of AR remote technology implementation

- Companies encounter very few technical barriers, which could include the usability of smart glasses and low data transmission rates in the field.
- Companies encounter considerably more organisational barriers which are more likely to cause implementation projects to fail than the few technical barriers.
- The service business model must be reconsidered because AR-based service delivery encompasses a threat to service technician deployment sales and high-margin spare parts sales.
- This is more of a change project than a technical innovation project.
- The strategic dimension is not sufficiently taken into account in many projects; AR remote technology opens up new strategic opportunities, but these are not guaranteed and must be seized.

Maturity of AR Remote Technology – The Context of this Study

Figure 1: AR remote service scenario

Effective and efficient service delivery in capital goods industries is essential to meet constantly rising customer expectations. This applies regardless of whether the services are an unwelcome necessity or a strategic business area. It is just as important for small and medium-sized companies with a few service technicians as it is for large enterprises with a worldwide service organisation. Remote services are an established part of the service portfolio in most capital goods industries to deliver customer support effectively and efficiently. In many cases remote services are still provided by telephone apart from remote access to the machine control system. However, particularly since the Covid-19 pandemic, which severely restricted intensive travel for service technicians, more and more capital goods manufacturers have been implementing AR remote technologies, enabling collaboration between remote experts and technicians at the installed base (see Fig. 1).

The functional scope of commercially available AR remote software to enable remote collaboration ranges from video-calls, which are enriched with simple symbols, dotting, or freehand drawings in the frozen/live image, to integration solutions in the existing service management IT landscape (ticket systems, service contract management, spare parts catalogues, etc.). AR-devices used to run remote AR-Software include smart glasses as well as smartphones or tablets.

There were also many reasons to implement AR remote technology priod to the Covid-19 pandemic. The complexity and variety of the installed base often requires collaborative troubleshooting by interdisciplinary teams. Many companies complain about ever longer training periods for new service technicians due to decreasing qualifications. Companies of all sizes struggle with the necessary service competence in foreign markets. Large organisations are also confronted with high fluctuation rates in their subsidiaries, a small and scattered installed base in foreign markets, and globally distributed know-how. One tool to meet these challenges is AR-based remote services.

Since the end of 2017, the APPRISE research group at the Frankfurt University of Applied Sciences has worked with 25 capital goods manufacturers that have tested and implemented AR remote technology (see Fig. 2). The aim of the study was to identify use cases, benefits, and challenges of AR remote technology implementation, as well as to point out design options for future service business models. This study did not involve issues of data protection and liability, although it is important to note that both topics are very relevant for operational use.

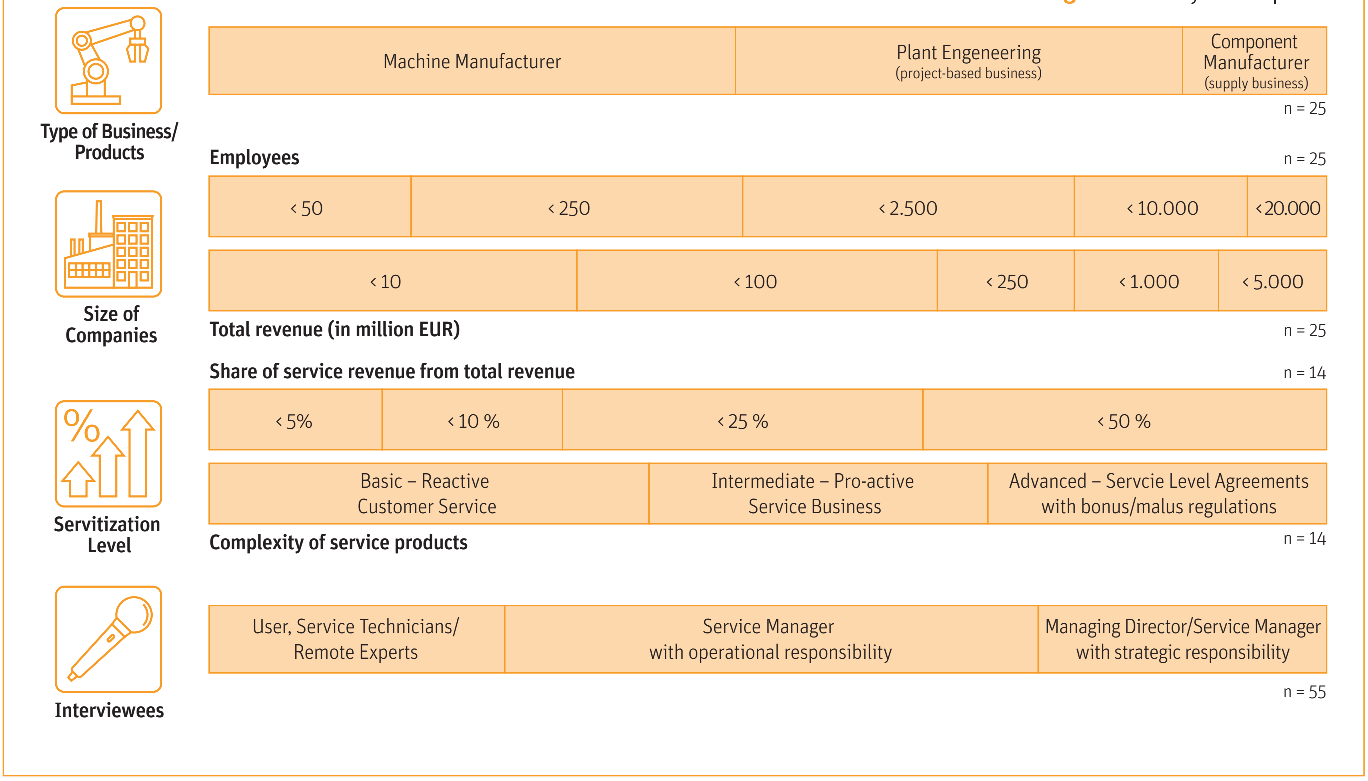

Figure 2: Study Participants

The findings of this study were derived from interviews and workshops with strategically and operationally responsible managers and users of AR remote technology, namely remote experts and service technicians (Fig. 2).

Use Cases for AR Remote Technology

In general, all classic service offerings can be supported remotely with AR remote technology. Figure 3 shows common applications of AR remote technology. Differentiating characteristics for these applications are the type, intensity, and direction of knowledge transfer as well as the device used. The differentiation is important because the benefits and challenges of the implementation depend on it. Use cases for AR remote technology can be divided into two categories.

The *Customer Service* category includes all applications where customers are supported directly by the remote expert of the machine manufacturer (OEM). In contrast to the *Field Service* category, an OEM remote expert supports the service technicians of their own organisation or the service technicians of a service partner. The OEM service technician can also be supported by remote experts from a component supplier.

Use case relevance depends on the individual situation and service strategy of the company that is considering the implementation of AR remote technology. If it is a strategic goal to become more independent from third-party service providers, customer service use cases are particularly relevant. If a company is acutely struggling with an aging workforce and must train many inexperienced service technicians, field service may be at the top of the priority list. If the corporate strategy is aimed at expanding into new markets, the integration of service partners and component suppliers into field service delivery may also be required.

AR based customer service

The obvious application for AR remote technology is in the direct support of the customer‘s machine operator or maintenance personnel, either through ad-hoc AR-based services (hotlines), scheduled sessions for regular inspection and maintenance, or application-specific process optimisation.

OEMs can also use AR-devices for preliminary acceptance tests or product tests in their own factory while the customer watches on their screen and accepts the result.

Remote trainings can be provided in 1:1 and 1:n training concepts. On one hand, trainers can conduct operator or maintenance trainings from their home desktop PC while trainees

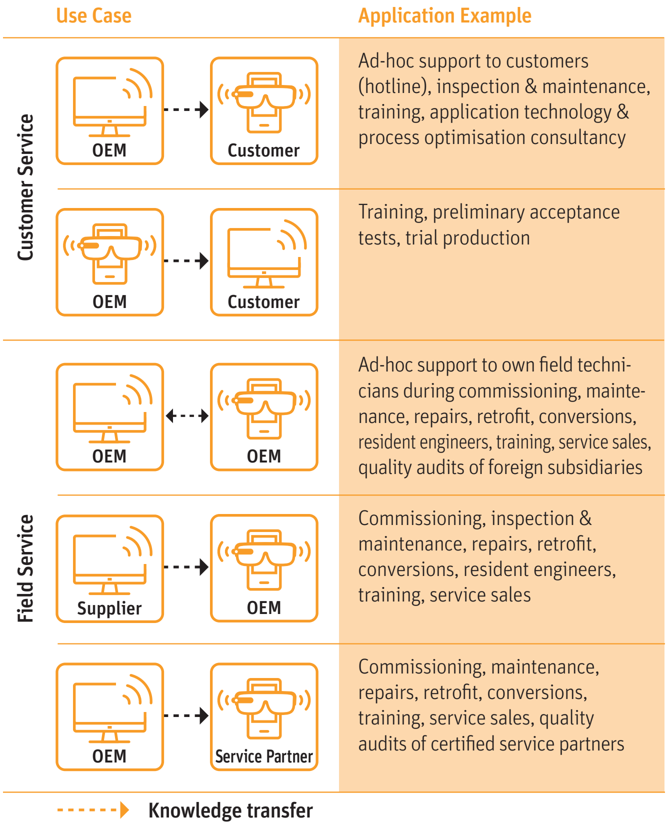

Figure 3: Service use cases of AR remote technology

are distributed around the world and are using AR-devices at „their machine". On the other hand, the remote trainer, equipped with smart glasses, can show the operation or maintenance procedures at a demonstrator machine located in the OEM's training academy or showroom, for example, and stream the live training session while the participants watch on their own screens and ask questions.

Employees who already provide hotline services, specialists from the specialist departments, and travelling service technicians can all act as remote experts.

AR based field service

The second major application area involves the support of field service technicians at the installed base. In this case, collaboration is not limited to employees of the organisation and can also include third-party providers such as service partners and component suppliers in the service delivery. The integration of local third-party service providers allows for quicker service delivery, thus enabling expansion into less penetrated markets. If a machine breaks down and an OEM service technician is already on-site, the integration of component suppliers can also prevent additional service interventions.

Commercially Available AR Remote Technology

In theory, many AR-software solutions support smartphones and tablets as well as smart glasses. Whether smartphones and tablets or smart glasses are the more suitable devices depends on the specific application. The advantages of one device are the disadvantages of the other; for occasional use, smartphones or tablets, which are frequently used anyway, are more suitable. The handling of smartphones and tablets is intuitive and does not have to be relearned, plus they provide longer battery runtimes, larger displays, and higher computing power than smart glasses. Smartphones and tablets are also more suitable if regularly displaying wiring diagrams or exploded-view drawings is necessary due to their larger displays.

Smart glasses are advantageous when the hands-free aspect is important and are used regularly for cases such as the initial training period of new service technicians. For industrial usage, smart glasses must be robust, must not impair the field of vision too much, and must offer sufficient comfort in order to be worn permanently. Therefore, monocular smart glasses are more suitable than binoculars. Additional requirements such as voice control and explosion protection are also occasionally required (e.g., RealWear HMT-1Z1).

The choice of the AR remote software provider depends on the functional scope and integration requirements of the AR remote software into the existing service management IT landscape. The software providers essentially differ in the following features: AR communication tools, data compression capabilities, compatibility with smartphones/tablets and smart glasses, video recordings for documentation purposes, case management, maximum number of participants in remote sessions, and integration capability into existing systems (SAP, Innosoft, Quanos etc.), as well as data security (certification according to DIN ISO 27001). The prices for AR remote software licences range from 600 to 5,000 EUR per year.

Best practices involve good data compression, high device compatibility and operating system independence, mastery of the relative alignment of AR mark-ups (symbols, dotting, freehand drawings) to the real object, allowance for more than two participants in a session, and enabling the white labelling of the AR remote software.

Advantages and Opportunities of Implementing AR Remote Technology for OEMs

Regardless of the functional scope offered by AR remote software providers, every solution creates a real-time situation awareness for remote experts through synchronous audio-video transmission. Communication is less dependent on the spoken word as it is supported by additional AR communication tools such as AR mark-ups on the live image. This applies both to the spoken national language and the individual technical language of the company. Therefore, misunderstandings in collaborative fault identification/troubleshooting between remote experts and technicians at the installed base are reduced and language barriers are overcome.

Many AR remote software systems allow additional participants to be added spontaneously to a remote session. This theoretically enables interdisciplinary troubleshooting with different departments or third parties in real time. These factors show the efficiency and effectiveness potentials for the service delivery of AR remote technology as compared to telephone support, which in turn enables service business potentials. Table 1 shows the potential of AR-based remote services assigned to the five use cases illustrated in Figure 3.

Effectiveness and efficiency potentials for service delivery

Real-time collaboration with AR remote technology shortens the average time spent on remote service interventions and increases the remote troubleshooting rate. Remote experts traditionally have to attempt to narrow down the causes of faults with customers via the telephone but the improved situational awareness of remote experts ensures that an on-site situation can be assessed more quickly and accurately. Significant time delays in fault detection, such as those caused by customers sending photos or videos for the wrong component or from the wrong perspective, are eliminated. This not only reduces the mean time of remote fault detection or troubleshooting but also increases the number of faults that can be corrected remotely. This in turn increases the remote troubleshooting rate and leads to significant resource savings.

In addition to customers, the most experienced service technician sometimes reaches his limit and needs a second or third opinion from colleagues in specialist departments now and then. Therefore, the mean time of on-site intervention can be reduced and the first-time-fix-rate can be improved. Targeted field service deployment planning and documented service history play a decisive role with regards to the first-time-fix-rate. If OEMs know in advance which spare parts, special tools, and skills will be required for the service job, they can avoid second field service deployments. In addition, AR remote technology opens up more possibilities for deployment planning. Now, even a less experienced service technician or a colleague with a less than perfect profile can be sent to the customer. As a result, less experienced service technicians are able to work independently sooner, which reduces the initial training period for new service technicians („second man“) and is one of the main motivators for the implementation of AR remote technology.

Many OEMs expect AR remote technology to improve the quality of service of their foreign subsidiaries or third-party service partners. Backed up by an expert from the OEM's headquarters, the skills of local colleagues are enhanced and their troubleshooting competence improved. This does not mean that laypeople without the appropriate technical qualifications will be able to perform complex service activities in future but the level of qualification or experience may be somewhat lower than in the past. This will allow for a greater involvement of customers or third parties in the service delivery to balance variations of service capacity utilisation, which will reduce the travel load of rare experts.

Service business potential

The efficiency and effectiveness potentials for service delivery offers an improved value proposition to customers, which can in turn be monetised by the OEM. This can be achieved through either innovative service products such as remote training and remote commissioning or by improving the quality of the existing service offerings, such as reducing downtime for customers while using fewer resources.

Less resource input leads to lower service prices and thus to lower service purchasing costs for customers. Lower service prices, in turn, open up the possibility of reaching particularly price-sensitive customers, such as self-maintainers, who have not used the OEM service so far and have only bought spare parts, if they made any purchases at all. AR remote technology enables expansion into new markets because service partners can be integrated in the service delivery more intensively as their capabilities can be improved by OEM backup. AR remote technology also allows for the bypassing of market intermediaries such as dealers and third-party service providers and enables direct services delivery to customers. These examples illustrate that AR-based remote services create new strategic opportunities.

Table 1

Benefits & Opportunities of Implementing AR Remote Technology

n = 38 Interviewees
16 Companies

	OEM → Customer	OEM → Customer	OEM ↔ OEM	Supplier → OEM	OEM → Service Partner
Effectiveness and efficiency potentials for service delivery					
Balancing variations of service capacity utilisation	■				■
Documentation of service delivery (service technician deployment/training/acceptance test etc.)	■	■	■	■	■
Raise service capabilities			■	■	■
Increase remote troubleshooting rate/ reduction of avoidable field service technician deployment	■				■
Reduction of mean time of on-site intervention			■	■	■
Reduction of mean time of remote fault detection/troubleshooting	■				■
Reduction of service technicians initial training periods			■	■	■
Reduction of experts traveling load	■	■	■	■	■
Reduction of non-productive hours/ non-chargeable hours	■		■	■	
Increase on-site first-time-fix-rate/ less second service operations			■	■	■
Reduction of pressure on individuals during on-site interventions			■	■	■
Targeted field service deployment planning (required skills/spare parts/special tools etc.)	■				
Service business potentials					
Direct service delivery to end-customer/bypass market intermediaries (e.g. dealer or third-party service provider)	■	■			
OEM service at lower prices/ reduction of customer's costs	■	■			
Proof of innovativeness towards customers and service recruits	■	■	■	■	■
Service revenue through innovative service products	■	■			■
Reduction of customers downtime	■		■	■	■
Reduction of warranty costs/reduction of overhead costs for uncharged service delivery	■				■
Service quality (e.g. faster service delivery, improved capabilities)	■	■	■	■	■
Improved customer satisfaction	■	■	■	■	■

Challenges of Implementing AR Remote Technology

Companies encounter few technical barriers during the implementation of AR remote technology. The primary challenge lies in the management of the implementation and the adaptation of the service business model. Table 2 lists the challenges and risks of implementation.

Technical barriers: usability of smart glasses and low data transmission rates

The assessment of the degree of maturity of monocular smart glasses varies greatly on a personal level. Judgments of service technicians range from „absolutely suitable for industrial use" to „not applicable". Nevertheless, most companies conclude that monocular smart glasses are mature for industrial usage – not only because improvements in battery life, operability, display size, and comfort are expected in the near future.

A general problem with smart glasses is the natural head movements of the wearer, which can cause the video stream to be too wobbly for remote experts to significantly improve their situational awareness. There are also occasional safety concerns when service technicians wearing smart glasses need to bring their heads very close to spindles or the control cabinet for remote experts to assess the situation.

Health complaints also occur sporadically; both remote experts and service technicians may experience dizziness and headaches.

However, the main technical barrier to be overcome is low data transmission rates in the field. The installed base is most often located in rural areas and in buildings with shielding or steel construction or those located underground (cellars, mines, etc.). Therefore, mobile data transmission rates are often insufficient, and it was sometimes reported that even the customer's local internet access does not allow for fluid video transmission. However, this barrier can be overcome in most cases either by using the machine's VPN gateway as a hotspot (if the machine is connected for remote access to the machine control system anyway) or by using mobile access points, although this can be very expensive, as in the case of mobile ad-hoc radio networks (MANet, satellite mobile radio). Nevertheless, most companies expect 5G technology to remove this barrier in the foreseeable future.

Implementation projects fail not because of technical barriers but because of organisational ones

The general prohibition of the customer in terms of outgoing data connections is rather problematic. In such cases it is usually only possible to persuade customers to agree on non-disclosure agreements to ensure outgoing data connections to service the installed base. The AR remote software providers are confident that they have found a solution in every concrete case, even in very sensitive industries.

Once this barrier is overcome and service technicians have general access to the installed base, another barrier appears in the form of the customer's IT restrictions. There is hardly a production or maintenance manager who is not open to AR remote services at first sight. The crucial question, however, is whether they will also be able to convince their IT departments to create the necessary prerequisites. Not only do the AR devices have to be integrated into the internal IT infrastructure, support from the customer's IT department is also required in the event of problems caused by firewalls or proxy servers, which can lead to poor video quality. Service technicians being more concerned with their new tool than with their actual service job leads to dissatisfaction among customers and service technicians.

Persuasion is also required with respect to the own organisation's employees if they do not see the relative advantages of AR remote technology for themselves. Therefore, service technicians are much more sceptical than remote experts and technicians with a lot of experience are more sceptical than less experienced colleagues. While remote experts immediately recognise a significant added value to their work in the form of improved situational awareness, service technicians are more likely to be afraid of transparency, excessive demands, and replaceability. It is not uncommon for them to put ostensible reasons forward, including that the technology is not sufficiently developed or that the customer does not want to do without service technicians on site.

Change management is therefore necessary both towards customer and within the own organisation – an aspect many companies have completely underestimated. Suppliers of AR remote technology advertise their offerings with a plug & play promise but considerable resources are required within a given organisation to implement AR remote technology successfully. AR remote software providers can certainly provide support with their experience, for example when it comes to non-disclosure agreements with sensitive customers or to suggest technical solutions for overcoming the data transmission barrier. Ultimately, however, success depends on a project manager implementing a cross-departmental project and overcoming many stumbling blocks. Top management support is necessary not only for the initial investment but also for the involvement of other departments for whom the benefits of

Table 2

Challenges & Risks of Implementing AR Remote Technology

n = 38 Interviewees
16 Companies

	OEM → Customer	OEM → Customer	OEM ↔ OEM	Supplier → OEM	OEM → Service Partner
Technical Challenges					
On-site data connection: low mobil data/ Wi-Fi transmission rates			■	■	■
Health and Safety	■	■	■	■	■
Usability of monocular smart glasses	■	■	■	■	■
Organisational Challenges					
Provision of resources required for implementation	■	■	■	■	■
On-site data connection: outgoing data connection prohibited/ access to on-site Wi-Fi denied			■	■	■
External User Acceptance	■	■		■	■
Internal User Acceptance (more service technicians, less remote experts)		■	■	■	
Management of the implementation project	■	■	■	■	■
Support of the customer‘s IT department required			■	■	■
Access to customer‘s site denied: protection of intellectual property/ personal privacy; obtaining film permit very time-consuming			■	■	■
Challenges & Riks for Operational Use					
Service knowledge drain	■			■	■
Adaption of business model	■	■	■	■	■
Decrease of revenues resulting from traditional field service technician deployment	■				
Decline in personal customer contact	■	■			■
Availability of remote experts	■				
Willingness to pay for remote service/ enforceability of value-based prices	■	■			

the project are not obvious at first glance. In addition to the integration of sales and marketing, R&D, technical documentation, and master data as well as IT, the early integration of users (remote experts and service technicians) can also be a success factor. This is especially true when service technicians are particularly sceptical.

One of the key findings of this study is therefore that AR remote technology implementation is more of a „change“ project than a technical innovation project.

Challenges & risks for operational use

In addition to the change aspect, the strategic perspective is also not given sufficient focus by many companies. AR remote technology is seen as a „painkiller“ for urgent operational problems (long initial training periods, lack of service competence in remote markets, etc.). However, the fact that most of the potential benefits can only be leveraged if innovative service products are developed around AR remote technology and actively distributed sometimes falls by the wayside. How exactly are additional service revenues generated when the risk that revenues from the deployment of service technicians would decline if the remote troubleshooting rate increases but the willingness to pay for remote services is traditionally low? How can the fact that (unintentional) training of customers during remote service interventions ultimately leads to decline in revenue be prevented? How can the traditionally high margin on spare parts remain high when technical assistance is much faster than the spare part from the OEM warehouse, i.e. the customer prefers to source the spare part locally? In a word: what should service processes and the service business model look like in the future?

Design Options for AR based Business Models

Some impacts on existing service business models and design options for future business models are pointed out as follows. However, business models are so dependent on use cases and the individual corporate strategy of a particular company that this section cannot describe one overall AR remote service business model.

Reaching new service customers

The target group for customer service use cases are primarily existing service customers, particularly those who already use other remote services such as charged hotline support, allow remote access to machine controls of their equipment, are familiar with the subject matter, and therefore can quickly recognise the added value for themselves.

Customers from regions where no local branch office is available can also be tapped into for AR remote services because they previously had to accept very long wait times for a service technician to be on site or rely exclusively on local third-party providers. This creates a potential for new service customers because expensive and time-consuming service technician travel is no longer needed unconditionally. This applies not only to customers who were previously serviced by third-party providers due to their geographical location but also to particularly price-sensitive customers or self-maintainers who make little or no use of the OEM's service offerings.

In addition to existing customers, totally new customer groups can be developed. This is the case, for example, if third-party service providers are willing to pay for the OEM's AR remote services to expand their own service offering. One example is a forklift truck manufacturer that carries out the service for the fleet of a logistics service provider under a service level agreement. Because the forklift truck manufacturer purchases AR-based remote services from the manufacturer of the rack storage systems used by the logistics service provider, the service level agreement can also include the storage systems. The storage system manufacturer now generates a turnover that it would not have otherwise realised because the service would have been carried out internally or by local third-party service providers.

New value propositions and revenue potentials

AR remote technology enables the improvement of several service KPIs, such as mean time of remote and on-site service interventions, remote troubleshooting rate, on-site first-time fix rate of service technicians, and productive or chargeable hours. This can result in less downtime for the customer and lower service costs. However, machine manufacturers should also pursue the goal of converting the increase in service quality into chargeable service products that offer additional high-margin sales potentials or at least prevent previous sales from being lost without replacement potential.

Revenue potential can arise in three ways, firstly by attracting new customer groups as described in the previous section; price-sensitive customers can be developed, for example, by offering comparatively inexpensive remote training or hotline services.

Secondly, the fact that an improved value proposition and less risk for the customer justifies more expensive service level agreements. In addition, more service level agreements can be sold, for example by foreign subsidiaries that previously lacked the necessary skills but can now enter into service level agreements with their local customers.

Thirdly, and indirectly, by developing new innovative services which do not generate revenues directly but which may serve as a selling point, e.g., remote commissioning or remote pre-acceptance tests. In these cases, the AR remote technology is the direct enabler for a new type of service that was not previously possible.

Revenue models for AR based remote services

For applications in which the customer wears the smart glasses, the customer either obtains the smart glasses himself (or already has some) or they are offered by the OEM. If this is the case, the customer has a higher expectation of support if problems with the smart glasses occur. The smart glasses therefore become an additional installed base. The question that arises in this case is: should the price of the smart glasses be made transparent? In principle, the smart glasses can be provided free of charge either as part of the AR-based service or separately. The pricing of the smart glasses can be treated in a similar way to other required hardware as in previous remote service level agreements, for example, the hardware to realise access to the machine controls.

We believe that smart glasses in a valuable packaging can contribute to the willingness to pay for remote service level agreements, as the smart glasses are tangible representations of the intangible service product. An AR remote service app can play a similar role. Via the app or smart glasses, the service becomes tangible and improves the customer experience, which is not so much the case with telephone hotlines.

The real issue, however, is not the pricing of the smart glasses themselves but the revenue model of the AR-based service products. Possible revenue models include „pay-on-demand"

and „prepaid". Pay-on-demand means that payment is made after the service has been provided while prepaid means that advance payments are made for hourly quotas. The prepaid model has an advantage in that, for example, during night shifts, when no orders can be placed by the customer, AR remote services can still be available. Both pay-on-demand and prepaid models offer various forms of billing such as 30 minutes intervals or flat rates per case.

As hitherto, the familiar design options for service level agreements are available: for example, a remote service level agreement for hotline support and remote access to the installed base, clarifying all data protection and data connection issues. The price of existing remote service level agreements should be adjusted to reflect the added value as compared to telephone support. In addition, higher prices would be a way of compensating for declining sales from service technician deployment and spare parts sales.

One strategy for selling remote service level agreements involves not charging for AR remote service during the warranty period or to price very low until the warranty has expired. When customers have become accustomed to the services and warranty has expired, contract possibilities can be pointed out. However, this means that the service would have to be discontinued without a follow-up contract.

Investments pay off quickly

The cost structure for delivering AR based services is negatively affected by AR remote software licenses and the required hardware, such as smart glasses and access points. The additional costs incurred by remote experts have also been discussed time and again. However, we argue that, strictly speaking, these are not additional costs. Remote experts are either hotline staff and departmental employees who already provide these services or service technicians who are now needed less in the field and can therefore be in the office more.

The increase in productivity in service delivery described in detail above has a positive effect on cost structure. Most noticeably, more service cases can be carried out in less time, travel in warranty is reduced, and the improvement of first-time-fix-rate leads to fewer non-chargeable second deployments.

Depending on the selected configuration, the initial investment in AR remote software/hardware pays off after a few saved service deployments during the warranty period.

Knowledge and remote experts are the key resources

At the heart of any AR remote service is the provision of knowledge. Therefore, in addition to the necessary software and hardware, remote experts in particular are a major resource of the new AR remote service business models.

Even though it is not a new phenomenon, companies, especially those not yet offering some other kind of remote services, have to deal with the knowledge stored „in the heads" of remote experts because this is a threat to the service business model. Therefore, a digitalised, well-documented service history, from which the remote experts draw their knowledge, is becoming an increasingly important part of the AR remote service business model. Rarely is necessary knowledge stored completely and in a structured manner in a knowledge database but only made available to remote experts. An essential activity of the service business model is therefore to ensure the provision of knowledge.

Furthermore, the remote expert has a decisive new role as a sales representative. In addition to service technicians, remote experts providing hotline services are the ones who can most effectively draw attention to the new service offer, especially when smart glasses are not required and the note „do you already know our new app?" is sufficient to demonstrate the improvement as compared to telephone support. The increased situational awareness enables remote experts providing hotline services to find starting points for additional service offers. This makes them an important catalyst for service sales that can now offer more existing field services.

Ultimately, all AR service business model opportunities are based on the strategic priorities of the respective OEM. If the company's strategy is to give away services as a selling point for a high-margin new machine business, the implications for reasonable business models are different than if the spare parts business is to be saved, and also different if the focus is on expansion into the Asian market by involving service partners.

Recommendations for the Implementation of AR Remote Technology

The number of implementation projects in capital goods industries carried out in recent years illustrate that AR remote technology is ready for industrial service use. AR remote technology can be used for a variety of applications and alleviates the typical „pain“ of industrial service delivery. On the other hand, the implementation of AR remote technology is not a surefire success. Therefore, we provide some recommendations for a successful implementation project. Our recommendations in Figure 3 are explicitly not to be understood as a sequential process. Depending on the situation, it may be reasonable to change the sequence or to proceed iteratively.

Outline the big picture – but start small

The starting point of the implementation project should always be the service strategy because it determines reasonable use cases and business models. Create a long list of visionary use cases and outline the „big picture“. Describe your use cases as concretely as possible in terms of type, direction, and intensity of knowledge transfer. Think especially about the type (e.g., spare part identification, maintenance, fault detection) and intensity of knowledge transfer because knowledge drain might be a threat; it must be ensured that third-party service partners, for example, also have access to necessary knowledge. In addition, describe who uses which devices to perform the service and for what purpose.

Start with use cases that can be implemented in the short term and which have a lot of internal acceptance because this lowers barriers over the course of the project. Later on, you can implement more complex use cases through process integration such as ticket systems, workflows and AR-based step-by-step guidance for standard problems, spare parts availability and integrated ordering processes, service technician reports and automated invoicing, knowledge management systems and many more.

Gain experience with the AR Remote Software

Start with an internal testing phase and understand what different AR remote software and devices are capable of. This is an important step for better assessment of the feasibility of use cases. Choose AR remote software with different functional scopes and test both smartphones/tablets and smart glasses. For monocular smart glasses, we recommend the RealWear HMT-1. Contact us or the well-known consultants for a market overview of AR remote software.

Involve service technicians and remote experts early on in the project so that they do not feel left out. Make sure that service technicians are not frustrated during the internal testing phase and consequently reject smart glasses just because the plug & play promise has not been kept.

Focus on the value proposition to your customers groups

Describe the concrete value proposition for each customer group and each selected use case. To this end, identify concrete pain points of the customer groups and describe how the use case addresses these pain points. Value Proposition Design is a good example of a method. We also recommend doing this for supposedly internal field service use cases because value proposition can change in these cases too. For example, alliances with service partners become possible whereby shorter reaction times can be guaranteed. If this is a value proposition that was not possible before, service level agreements at higher prices are now possible. However, you should also check whether you are prepared to grant these service partners access to the necessary know-how, which includes factors such as spare parts identification knowledge.

Start with a concrete description of the value proposition and then design the business model for each use case. The Business Model Canvas is a good tool for this.

Business model development also involves defining the KPIs that will later be used to measure the success of the new business models. Success measurement is also important for later business model adaptions because it is the basis for the design of new service level agreements, among other things. This ensures that only commitments that can be kept while staying profitable at the same time are agreed upon in future service level agreements.

Design service processes as the basis for requirements analysis

Service processes designed for each business model are important because only process modelling makes the actual requirements of the software transparent. It might become transparent whether, for example, the AR remote software must be able to support more than two remote experts or whether integration into the existing service management IT landscape is required. Service blueprints, event-driven process chains, or other process modelling methods can be useful tools.

Regarding the requirements analysis, you should focus on the evaluation of the AR remote software. Regarding the AR devices, you must only decide whether and/or for which use cases smart glasses are required. It is important to note that very few models are suitable for use in industrial service applications. Smart glasses are only useful if they are used regularly and the hands-free aspect is indispensable. The more critical part is to ensure on-site data connectivity and access to the installed base.

Pilot MVP with customers who like to experiment

Pilot a Minimal Viable Product (MVP) with a few customers who want to experiment with you. Then you can put the business model and service process designs to the practical test and then readjust them. Complete the developing of service products with the AR remote software provider and possibly other software partners.

We advocate for not launching an MVP. You should offer market ready developed service products upon rolling out AR remote services, otherwise it will be difficult to enforce higher prices.

At the latest at this point in time, the marketing and sales departments should be integrated in order to jointly define sales channels and agree on sales targets.

Management support for selling AR remote services actively

Selling AR remote services can be more tedious than it seems at first glance because customers also must be ready and create conditions for its use. They might have to be convinced of the benefits of AR remote services. There is hardly a production or maintenance manager who is not enthusiastic about the idea, but the decisive factor is whether they are willing and able to convince their own IT departments to create the necessary conditions. Moreover, we believe that not everyone who is initially enthusiastic wants the changes in the long term. Just like service technicians, maintenance engineers and managers might fear transparency and replaceability, which can be a barrier for the project. Top management support may be necessary because discussions with customers about service level agreements, non-disclosure agreements, and IT integration may have to take place at higher hierarchical levels.

Changing the mindset of your own employees and internalising a new role also requires time and management support. If remote experts have new roles as sales representatives, management should be called upon because target agreements need to be adapted and employees need to be trained. If service technicians are to take over sales tasks, this must also be accompanied by the management. Although service technicians have previously been involved with sales, they have always been „selling themselves“, while they are now supposed to present service products which they may assume will replace them in the future.

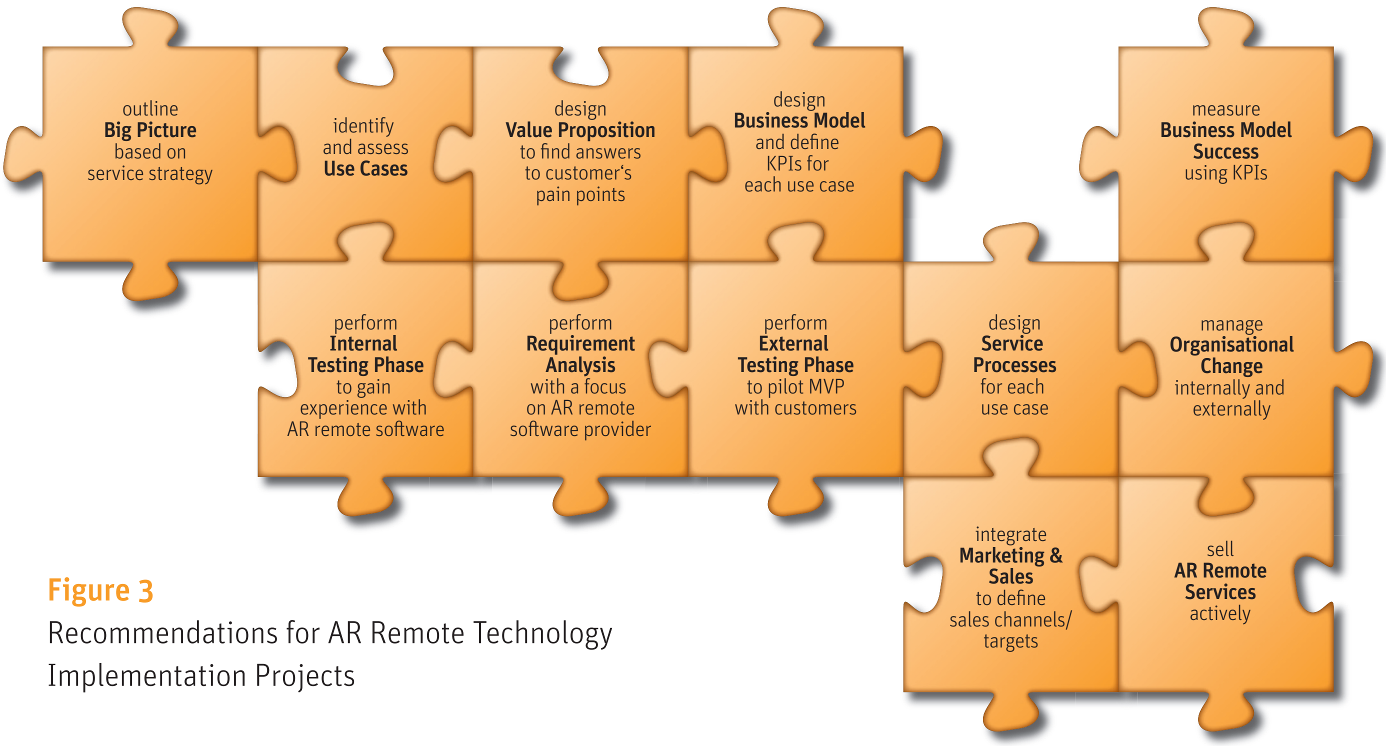

Figure 3
Recommendations for AR Remote Technology Implementation Projects

Who we are: APPRISE – Applied Research in Industrial Service

The APPRISE research group, headed by Prof. Dirk Stegelmeyer, is working on the digitalisation of the industrial service business. APPRISE researches in three main areas. Firstly, the implementation of Augmented Reality in the field service of capital goods industries; secondly, machine learning for predictive maintenance and thirdly, the development and evaluation of business models for smart services. All topics are carried out in cooperation with the Mobile Computing Research Group headed by Prof. Jörg Schäfer from the Fankfurt University of Applied Sciences and the Energy, Emissions, and Environment Research Group (EEERG) headed by Prof. Rakesh Mishra from the University of Huddersfield/UK.

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Learn more about our applied research at
www.frankfurt-university.de/APPRISE

Prof. Dirk Stegelmeyer

Prof. Stegelmeyer graduated 1996 as a Doctor Ingeniero from the Technical University/Madrid after obtaining a Bachelor of Commerce at Wits/Johannesburg and a Masters in Industrial Engineering at the Technical University/Darmstadt. He has comprehensive professional experience in industry in positions such as Managing Director at DMG Mori, MAKINO, United Grinding, and SCHIESS. His work focuses on corporate management, service development, and operational restructuring. He gained far-reaching competence in fostering international business working for Asian shareholders, dealing with global customers, and setting up international subsidiaries.

Prof. Rakesh Mishra

Prof. Mishra is an active consultant to many Thermo-fluid industries and has run a number of knowledge transfer partnerships successfully. Prof. Mishra completed his PhD from renowned Indian Institute of Technology, Delhi, India in 1996. Professor Mishra leads the 'Energy Emission and the Environmental research group' within the School of Computing and Engineering, at the University of Huddersfield. Prof. Mishra has published more than 300 papers in various journals and conference proceedings of repute and has been invited to give key note lectures in various conferences. Prof. Mishra has also organised and chaired a number of conference sessions dealing with green issues.

Prof. Jörg Schäfer

Prof. Schäfer graduated in Physics in 1991 and completed his Doctorate in Mathematics at the Ruhr University Bochum in 1993. Prof. Schäfer worked in leading consulting firms and guided global companies for many years. He has profound experience in the conception, development and realisation of complex IT systems and in strategy development with optimisation of business processes for large companies. At the Frankfurt University of Applied Sciences, where he has been teaching and researching since 2009, he works on machine learning with a focus on pattern recognition and evaluation of sensor data as well as distributed systems. Prof. Schäfer is the author of numerous publications and a member of the review board of the journal MDPI Information.

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