# The Challenges With Implementing XR In the Industry

## A study on why industrial companies haven't fully implemented XR yet


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# Introduction

This report about the challenges of implementing XR[1] (eXtended Reality) is a part of the pre-study MAXAT. It's a combination of observations and reflections from interviews and meetings with the participating companies as well as other companies met at e.g. technology fairs and conferences.

In this research project we asked ourselves: if AR and VR are such powerful and useful technologies – how come more industries haven't implemented them in their daily work? We could think of several reasons for this; relatively high cost to produce XR content, security issues with sharing construction files and challenges for the management to see a real business case. But, we also knew there must be more of these challenges out there. The main goal with this study was to identify these challenges and, if possible, come up with ideas on how they could be solved.

MAXAT was a collaboration between RISE, Tetra Pak, Komatsu Forest, byBrick Interface, Automation Region and PanView. It was a research project within the strategic innovation program PiiA (Process Industrial IT and Automation), which is supported by Vinnova, Formas and the Swedish Energy Agency. The study was conducted between September 2018 and March 2019.

1 Throughout this study we use XR as an umbrella term for VR (virtual reality), AR (augmented reality) and everything in between.

# Content

# The Challenges

The motivation from industry for using VR or AR is often to introduce someone to a machine or product, e.g. sales demonstration on a tablet, or perhaps interactive VR and AR training. With this technology operators and technicians can practice scenarios that usually are unavailable, or dangerous, in a way that is almost as good as the real thing.

## Common challenges

To help companies with this vision in a broad sense we decided, within the consortium, not to focus on any specific XR device (HTC Vive, HoloLens etc.). One reason for this is that the technical groundwork (like optimizing 3D models) is a common challenge for all these devices, and also we wanted to focus more on the information gaps industry companies face in a general way without pursuing a specific technical solution before the fact.

## Broad strokes

The list of challenges presented below are the findings from interviews with the participating companies, Tetra Pak and Komatsu Forest, as well as XR producing companies both in Sweden and internationally. Additional industry companies, who were outside this initial pre-study, have since its conclusion been eager to confirm these challenges within their own companies as well. While there are clear similarities between all of these companies there are also distinct differences in company culture, technology readiness level etc. Despite this the main challenges are very similar. In this report we will focus on the common denominators and general pain points that all these companies share.

## Introduction – Why the industry wants XR

XR is an exciting new technology, but that also means creating it is complicated and unknown for the industry. Software are usually targeted to game designers and have a high bar of entry, which also means fewer people have any experience with it. Today many industrial companies would like to do interactive training in VR or have 3D models appear in front of technicians in AR, but don't yet have the knowledge about how to do it.

### Video – a comparison

Video can convey information effectively in most situations and, compared to XR, is much easier to produce. The technology is well known, reliable, reasonably priced, editing software is free and most people have experience with it. This makes it a great starting point for more pedagogical training and is why industry companies are also exploring this option today.

### So why XR?

The main selling point for XR is *interactivity* and *immersion*. Even though it's more difficult to produce it's simply a more memorable way of communicating. In virtual worlds, it becomes possible to show objects and details from impossible angles, and let personnel train in scenarios with unlimited freedom and flexibility. These ideas drive industry to keep trying to implement XR.

## Exploring the XR business case

In this section we will get a glimpse of how industry companies are currently exploring the possibility of XR and trying to find a way forward with implementation.

### Demonstrators

During the interviews carried out at Tetra Pak and Komatsu it is clear that both companies have a vested interest in figuring out how XR technologies fits into the company's broader business model. The leaders of the companies are trying to determine if XR, not just in theory but also in practise, can help them save time and money as well as attract partners, future business and new colleagues to the company. In order to determine all of this, demonstrators are produced and experimentation is carried out, involving for example:

» Buying VR and AR equipment and setting it up

» Using third party software to try and create visualisations in VR and AR

» Viewing CAD (Computer Aided Design) models through the CAD software directly, in CATIA for example

The experimentation listed above yield interesting findings but only scratch the surface of the potential of XR. Although companies uncover, what is to them, *new* information about what they can, and cannot do, the results are usually mixed and always limited by the expertise of the person making them.

### XR explorers

At Tetra Pak and Komatsu XR demos and applications can be of interest to, and requested by, management or different internal divisions, such as sales department or

training department. The practical creation of a demo however, usually falls to people that have a closer relationship with technology. This can be engineers working with CAD or self-appointed XR tinkerers with little or no previous experience with VR or AR development initially. These XR teams within the companies are small (1-2 people) self-organized and mainly driven by their interest in exploring the tech. Engineers are experts at CAD drawing and construction, but not necessarily visual design and user experience which is heavily emphasized in XR development. The hardware and software needed for XR is also slowly being explored over time with new eyes, which is exciting for employees and leaders alike. However the lack of specific XR expertise can lead to demo production yielding inconclusive results. This, in turn, impact the business decision on weather or not to move forward with XR implementation. The decision then usually falls into the lines of "*Let's not invest yet*".

### Current state of XR initiatives in industry

The exploratory nature of the activities in industry is important as many XR projects become experimental in nature and thus falls outside of normal project funding. They usually take form as a side project or a smaller part of a bigger project. Sometimes the technological push comes from someone at the executive level but usually these XR explorers pitch concepts to make them happen. With some interest and support from management there is usually a go-ahead to keep experimenting, and a modest budget to buy XR equipment. There are however instances where exploration of XR is completely outside regular working hours. One respondent described this as "*Possible for a while because we're passionate about it, but it's not sustainable in the long run*". Our reflection is that this structure will likely remain unchanged until there is a clear business case, in-line with the organisations strategy, that can justify bigger investments.

### Why the business case is not found

Many employees express in interviews that, if given the chance, they would like to expand their roles within XR development but that they are too busy with other projects and lack XR tools and information. This impedes learning and production of the demos and apps needed to prove a business case. The lack of in-house knowledge around XR in general slows progress further creating a vicious circle that leaves strong business cases for XR unexplored.

### Authors notes

Exploring and building XR is not easy. The XR tests and demos carried out by the industry may not always produce a clear business case, but these experiments are not failures. Rather, these are the first steps that outline what industry can, and cannot, do with the technology today. The willingness to expand knowledge in XR is the key that will determine how well they succeed.

## Challenges

» Experiences around VR/AR, and its opportunities and challenges, are limited

» XR development is usually a side project

» Difficult to find a concrete business case

» Lack of time and XR specific knowledge slows progress

## Suggestions

» Encourage exploring

» Keep expanding time and budget gradually

» Before building, define a XR application that would clearly prove the business case

## The importance of knowing the possibilities and limits of XR

Today there are software on the market that can import CAD data and automatically convert it to readable polygon models which are then displayed in, for example, a tablet. This technology is drastically simplifying and shortening the production of XR for the user but is also very limited. Industry companies understands that these solutions only scratches the surface of the full potential of VR and AR. Interviews indicate that Tetra Pak and Komatsu see this type of software as stepping stones to understanding what the technology can do. At the same time they conclude that more proprietary control is needed as well as a deeper understanding of XR creation to identify other solutions.

### Overview of XR

In interviews managers and leaders of Tetra Pak and Komatsu want to have more in-depth information about how XR is produced but also more specifically how much it costs to produce different parts of an XR application. These are identified by the industry as key decision-factors, and essential information to make the right decisions. Currently, in-house information is not yet conclusive enough for decisive action and the only way to remedy this is to ask for price estimations from potential subcontractors. These offers from outsourcing companies often doesn't provide the full picture. Industry companies get an answer on what a specific XR concept could cost, but not how the *cost is distributed* in the production. With limited understanding of possible solutions, industry companies are likely to fall into the trap of thinking they want something they have already seen, not knowing a cheaper and more effective solution is just around the corner. On top of that; people with different career backgrounds, lingo, experiences and frames of reference will often misunderstand each other, leaving many parts of the XR development to chance rather than calculated

choices that works best for both industry and developers. With information on hand, industry companies can instead look forward to discovering for themselves what technological solutions would fit them best and communicate this need, clearly, to subcontractors who can deliver accurate solutions for accurate prices.

### Deep orientation in XR

On a practical and technical level XR explorers in industry are hungry for more information about how XR works in practise. Questions about what techniques, pipelines, tools, software and plug-ins to use, are many. Understanding, on a deeper level, what challenges there are with HoloLens tracking, or how long it takes to build specific VR content compared to other types of 3D visualisation techniques will progress experimentation dramatically and potentially even eliminate the need for the types of demos that today are in the realm of trial and error.

## Challenges

- Explored solutions don't give the control and creative freedom needed for bigger projects
- There are no appointed XR experts in the organisation
- Not enough information about cost for development and what other solutions are useful
- XR explorers want more information but have a hard time finding good sources and tools

## Suggestions

» A pedagogical walk-through and overview of XR is frequently asked for by the industry, both in interviews, meetings and informal conversations. The reasoning here is that clear understanding of the technology will create a strong base for business decisions and planning the roadmap and vision for XR. We propose to do a series of workshops and XR focused seminars to help bridge the information gap

» A compiled source of information for XR explorers including inspiration, examples and resources

## Curiosity, involvement and maintenance

Throughout interviews, we received several examples of how important it is to involve the employees and end-users in the implementation of new technology. Employees seem curious about new technology on a general level and when allowed to ask any question respondents wanted to know more about what VR, AR, and AI can do in the future. In contrast they also helped us point to practical limitations that need to be taken into account. This section describes the main findings.

### Technology push is a problem

In the interviews there were several clear examples of technical implementations being pushed from “the top”. Respondents echoed that the technology they received rarely reflected their actual needs. However, the interviews also revealed how management, especially at Komatsu, had reacted to this and changed their behaviour. Employees on all levels started seeing very positive results as listening to worker needs became the first step in implementing technological solutions.

### Equipment maintenance

Interviewers pointed out that updating software must be easy, or even fully automated, if they are expected to be used. At both companies there are clear issues with security, on-site network access, GDPR issues and systems that automatically update in stressful situations. With XR, respondents pointed out that it will be unsustainable to rebuild the application every time a change or update is made. There will need to be a direct line to the information in XR if it is to remain updated at all times.

### No XR without involvement

All respondents pointed out that understanding the reasoning behind why a new

technology that was to be implemented is important. Providing education, support and follow-up, was also identified as key concepts for any system to stay relevant in the long term.

### Curiosity for XR

At both Tetra Pak and Komatsu the staff at all levels saw great potential for XR, with very few exceptions. When asked how the employees could see XR being used, the interview often evolved into full scale brainstorming sessions between the respondents, even without any encouragement from interviewers. This indicates a high interest for XR among the employees, and that, even without deep XR knowledge, they understand what the technology can do in their company. When asked if these ideas had been captured in any way the response was usually "*no*".

## Challenges

- Technology solutions being implemented are not always solving real problems
- Employees are rarely involved in the process
- Getting hardware and software updates to all parts of the company as well as company clients
- Ideas are plentiful but are not being captured and structured

## Suggestions

» Employees are curious and want to get involved. An XR workshop involving all employees would help capture good ideas and help build the vision for the company, and also include everyone in the process of implementation

## Internal competence, communication and coordination

### The need for coordination and vision

In interviews respondents mention the lack of coordination between internal XR initiatives as a problem. Both companies mentioned the need for someone, or a group of people, who can dedicate themselves to driving XR implementation within the company. Someone who can gather ideas from all levels of the company and help form the XR vision, and, in the end, turn that vision into a practical XR roadmap. Currently, XR explorers don't hold this knowledge themselves and the nature of hands-on development means overview is lost as soon as they engage in their daily technical tasks. Employees are usually also in different sections of the company which makes it difficult to explore and learn together. Respondents mention that without structure, coordination and a common vision there is little way of telling if one person is working on something that has already been implemented by someone else.

### Now hiring

In conversations and interviews with industry companies it appears very common to hire young talent and thesis workers to develop the demos that industries can't realize themselves. These young adults are generally tech-savvy and also know their way around the basics of 3D modelling and C# scripting. Google helps too. In the industry context they usually start with Unity development in some form to, again, prove the business value through demonstrators. However, they are not experienced game designers and have usually not worked with XR before. Although exploration is speeded up by these individuals they still need support to avoid the same pitfalls previously outlined in this report.

### Getting everyone on the same page

Some industry companies invest more heavily into this structure, sometimes even hiring people with game design experience to help guide the otherwise inexperienced team. It is worth pointing out that these people are usually not leaders themselves, but rather technologically oriented. These individuals will need education in management techniques, tailored to software development, in order to guide their team. They will most likely also need a comprehensive XR education package to make sure everyone's up to speed and speaks the same language.

### Communicating the practical work

The task of defining technical and creative assignments needs to be addressed as well. Here a rigorous communication methodology is needed to ensure that the vision for each project is communicated clearly between developers and industry clients. Without this individual who understands both customer needs and developers, the product will most likely fail or stagnate. Needs have to be a well defined and compiled into a well placed order to ensure developers are applying their skills towards a clear goal.

### Information dissonance

Different people at the company have very different competence level about XR. Executives and managers have often seen XR demonstrations presented to them at fairs and showroom floors but don't always realize that these experiences are created by professional XR teams with years of experience. Internal demos are usually made with existing plug-ins, with low bar of entry and severe limitations. These can seem great but lead to problems with managing expectations.

### Managing expectations

It can be easy to think that little work is needed to produce a full-scale XR application when in fact much more information, time and experience is needed to go from a demo to a product. This dissonance of information and perception can lead to a stressful environment when XR explorers who are unfamiliar with, for example game engines, are suddenly asked to deliver something they don't have the competence for. Usually this is discovered too late by everyone involved. Apart from the stress and frustration this process can cause it also ultimately leads to the same problem outlined before; slow or diffuse progress in finding the business case. If these internal tests lead to poor results the companies may even conclude that XR is not worth the effort. A potential solution for this is to turn to external collaborations or consultants.

## Challenges

» A specific leader to coordinate and drive XR initiatives is rarely part of the company

» Young, driven and talented but inexperienced developers needs guidance and orientation

» No comprehensive and outspoken XR vision for employees to follow

» Inconclusive information about the business case for XR makes it difficult to set a vision

## Suggestions

» A series of courses and workshops focused on understanding XR opportunities and challenges

» A technical orientation in XR to avoid pitfalls and mistakes and form a common understanding

» An orientation in cost for XR development as well as relevant solutions on the market

» An in-house expert with knowledge of VR and AR to drive development and prioritize projects, as well as forming concept proposals at company level. Initially this could be a consultant

» A methodology and framework that helps companies identify when to use XR, but also when not to use XR

» A course in the XR process and the designers lingo so industry can communicate confidently when placing an order

» A comprehensive and outspoken XR vision is needed to unify efforts inside the company. This can be done through a guided workshop, compiled into clear XR concepts, ready for executives to sign

## External competence, communication and coordination

### Planning and external orders

To see more clearly what can be done with XR, industry have tested out external collaborations. These are XR professional (like byBrick) and can in theory build any demo the industry wants. But communication, including understanding of file formats, handling file transfer (of CAD data for example) as well as conveying a vision and specific XR concept, is challenging. This competence often doesn't exist today within the industry companies which makes it difficult to create accurate descriptions and requirement specifications before placing an order. Interviews reveal how entire projects and XR initiatives have grinded to a halt due to the lack of a framework for preparation, continuous communication and follow up together with content creators.

### Security

Industry companies will have to share sensitive files with external collaborators if they want effective help in XR production. But industry companies are, understandably, not keen on sharing their valuable, millimeter-accurate CAD blueprints outside company walls. The measure from IT department is thus to stop any such file sharing, especially if it involves external servers. At Tetra Pak internal personnel and employees with a high enough security rating can download 3D files without major roadblocks. In special cases, access to the CAD management system can also be approved to consultants and subcontractors that have this security clearance as well as a signed NDA. Even without this, there are usually channels and procedures that makes file sharing possible in the end even though the process can be time-consuming and cumbersome. As reported from byBrick, content creators and other XR spe-

cialists, the search for the correct CAD models and assemblies is usually a big, time consuming pain. It slows down progress and drives up overhead costs. A coherent CAD system, like what Komatsu and Tetra Pak are aiming for, is the perfect solution as long as it can be accessed securely.

### Preparing and converting CAD

Choosing, compiling and delivering the right files at a reasonable level of detail also requires competence on both domains (CAD and surface based 3D) which often is not available within the industry companies. The engineers and CAD users in industry don't work with surface modelling and are unfamiliar with it's limitations. Content creators (XR consultants) are usually well oriented with polygon based 3D software (surface modelling), but lack either competence or equipment to handle CAD assemblies. Both byBrick and the industry explains in interviews how this lack of a common ground and understanding in this exchange often leads to overhead and frustration. There are software today that can do amazing XR, based on CAD, but only if the correct models can be found and sent. This problem has been echoed several times by many industry companies, both in and outside the consortium.

This concludes our section of XR challenges in the industry today. Keep reading to find out more about coming research as well as in-depth technical information about these challenges.

## Challenges

» Secure transfer of CAD data and other relevant information to consultants

» Conveying a vision and specific XR concept in a clear way to an external content creator is difficult

» Finding and identifying the correct 3D parts in different CAD assemblies

» Exporting CAD in relevant file formats for poly-conversion software and/or surface modelling

## Suggestions

» Working closely with external producers of XR is recommended, especially in the early stages of vision creation and information exchange. However, this collaboration needs support to function in the most efficient manner possible. Industry companies deserve straight answers and high quality XR apps that suit their needs and this can only be accomplished with exchange of information about each others way of working

» Help external collaboration by applying security procedures that everyone, including IT can agree on

» There are current XR creation software that can shorten the XR production pipeline while also providing control over the product. These need to be evaluated for efficiency and industry relevance by a professional eye and an independent party

# Technology Study

As a part of this project a technology study was also produced, the focus of which was to clarify, in more technical detail, some of the challenges mentioned in this report. This study has been shared within the consortium and we hope to build upon this material further as it could be the start of a compiled and essential pedagogical material for further communication and XR education.

## Introduction

*"Real-time 3D graphics is expensive and takes a lot of time"*

**But why?**
Simply put:

» Geometry must be extensively optimized
» Manual labour is still needed for 3D objects to look realistic

3D environments are typically created using hardware that costs 10x or 20x as much as the hardware that is used to consume them. The cost for 3D optimization is a one-time cost per object that makes sure that your content can be consumed with less expensive hardware and that gives good performance also in VR and AR.

This is still largely manual labour, which requires a 3D artist to either recreate the objects from scratch or using a combination of semi-automatic tools to deliver the optimized 3D content required.

## Technical background

In broad terms we can discuss three categories of 3D graphics:

### CAD – for engineers

Models are built using drawn and calculated shapes and surfaces, such as cylinders and cubes that are manipulated to the required level. In CAD software this is done using N.U.R.B.S or B-Splines, which are explicit forms that can be interpreted and processed.

Designing in CAD requires correct geometry and that it can be manipulated in real-time. When shapes are shown on a screen they are transformed into triangular shapes “under the hood”. This requires very intense calculations, and CAD software often need dedicated hardware to do this.

### Real-time 3D graphics

Models are created using triangular shapes directly to emulate the shapes that should be visualized. All polygons are transformed into triangular shapes before they are shown on the screen.

This geometry cannot be changed or modified, since the triangulation is done in the creation stage and the final model is static.

They are typically built less exact than CAD graphics, since the goal is to make the result look good visually rather than being sent for construction use.

### 3D graphics for film and animations

Offline rendering of graphics - results are typically created using a mash-up of all possible methods. Few limitations are necessary since the hardware has no time limit. The result is simply a series of rendered images which is arranged into a sequence.

There are several similarities and differences between these different categories.

One similarity is that all graphical calculations take place using triangular shapes. Whatever you are building, the product will always consist of these shapes.

Historically there has been a big gap between these categories, but the trend now seems to be that the technologies and methods are converging. CAD users are seeing the benefits of real-time rendering and software developers are creating new solutions to bridge the gaps. New technology is developing and is to some extent already available.

## The study: How to avoid unnecessary costs

### Sending the correct files

This can be trickier than it sounds. The team that orders XR projects often have very limited possibilities to review the source 3D-files, which results in the wrong models being delivered for production and smaller differences can easily fly under the radar. These mistakes can become very costly if they are discovered later on in the production process.

If the client cannot review the files, the supplier should do it immediately after de-

livery and double check any questions before the work is started. Communication is the key to avoid mistakes in this scenario.

### Eliminate intermediaries

If the client is a small project group within a large corporation, it can be a good idea to delegate the transfer of 3D materials to those who worked with the source files to begin with.

This can avoid misunderstanding on 3D formats and there is less need for the client to dive into technical 3D details. However, the transfer should still be double checked by all parties.

### Figure out the best infrastructure

Source files are often too heavy to send by email, and other means of transferring files tend to be very tedious or insecure.

A great solution to this problem is to work with suitable cloud services like Autodesk 360 cloud, that lets you upload files directly through the web browser, accepts all 3D formats and can do its own conversion into a format that is useful for both engineers and 3D artists.

### Make sure all details are included

We often see files that include placeholders, incomplete third-party parts or missing details like cords or cogs. This can quickly become a “black hole” in terms of time and budget.

Either we must go through the process of asking the client to produce better source files or rebuilding and improvising based on what we have.

### Build the right way

Make sure the geometry is put together accordingly. When the 3D artist has to reconstruct or repair CAD files, time is spent that was supposed to be invested in creating better optimized models.

### Material assignment

This area can often create issues that make projects inefficient. Make sure that the CAD files have assigned materials and colours and name the materials accordingly. If this is not possible, at least enclose clear instructions on what colours and materials there are.

The visual reproduction of materials in real time 3D is generally good, it is possible to create high quality surfaces and for instance see the clear difference between cast and brushed metal.

The more we know about the materials, the faster we can reach a good end product. Researching materials often takes a lot of time that can be avoided entirely by including this information from the beginning.

### Align the scope to the target platform

One of the costliest scenarios is to operate on a vague decision on target platforms.

If the client for example is looking to display a product through a HTC Vive system

with limited detail, we know from the beginning that we can use many shortcuts and move forward fast and at a low cost.

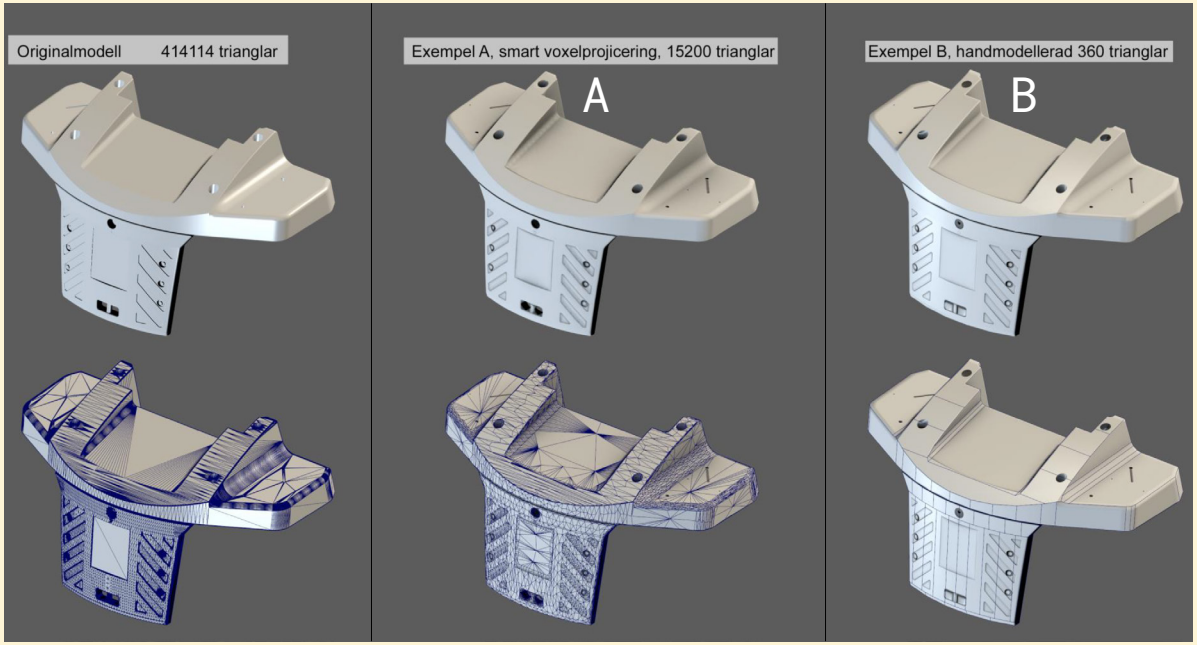
If the client first wants to use the models on a PC, but possibly also on an Oculus Go and maybe in Augmented Reality, we have to work smart and strategically with performance margins and heavy optimization.

As a result, if it turns out that the client only uses the model on a PC and does not move forward with Oculus Go or mobile projects, at least half of the work was for nothing and the models are much more optimized than they ever needed to be.

To set target platforms and scope from the beginning, as well as the level of visual quality required lets suppliers focus on the correct level and only perform the necessary amount of work.

Even if the client wants to move forward with more optimized models later, it can still be worthwhile starting on one target platform to be able to measure the benefits of the solution. This is great input on new investments decisions and limits the risk of investing in work which is never used.

## Optimization examples




| | Example A | Example B |
|---|---|---|
| Optimization rate | 96% | 99,9% |
| Suitable target platform | Real-time PC based apps, Oculus Rift, HTC Vive, Oculus Go | Everything. Possible to view in real time even on older smartphones. |
| Time spent on model | 1h | 4h |

| | | |
|---|---|---|
| Pros | Fast and streamlined.<br><br>Procedural and non-destructive.<br><br>To some extent the source model can be adjusted, and the changes can be reflected in the end result with very little manual work.<br><br>Good result in little time. Easy to scale, within certain limits. | A ”gold standard” 3D model<br><br>The result is very optimized and looks realistic.<br><br>Details are kept clear and clean. Full control over the result, technically and visually. Neat silhouettes. |
| Cons | The quality of the end results can vary a lot depending on the type of model. Large and solid objects often turn out good while cords, tubes and perforated surfaces generally turn out worse.<br><br>The result can look rugged if examined closely. Make sure to set the view distance properly. Models are still rather heavy, so to display many of them in the same scene may require more optimization.<br><br>The quality of silhouettes is a bit random. | Manual labour. Takes a lot of time which makes it expensive.<br><br>Requires a senior 3D artist. |

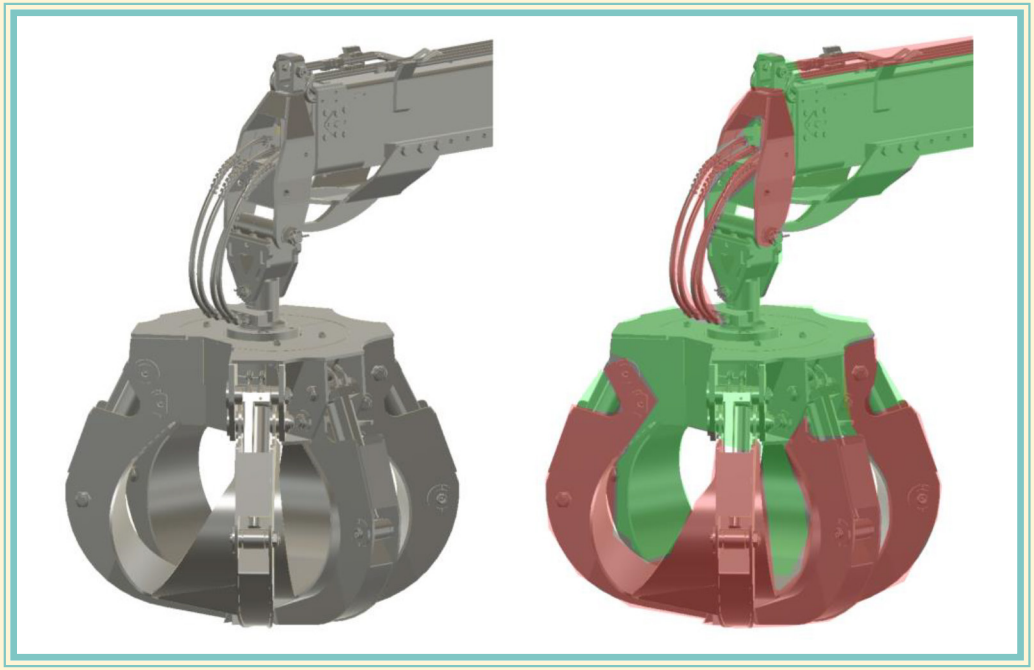
*This table draws a hard line between the two most common ways of attacking this problem. In practice the modelling work has more perspectives.*

### In the 3D artist's own words

*"Details that are easy to model by hand and that highly affects the end result is picked to produce the best looking model possible in the least amount of time.*

*If I was to be assigned to optimize this model I would build some of the details by hand (marked in red) and then set up a smart voxel projection on the rest (marked in green).*

*The rest is processed through a combination of semi-automatic tools that will give us the quickest route towards a model that includes all the required details."*



# Next Step

The key takeaway from MAXAT is that XR implementation in the industry is mostly slowed by the lack of information. Straightforward answers are needed for how XR can be used, or not used, how much it costs to buy and produce content and what competence is needed to do so. Knowing this will decide how confident companies are in their decisions to implement an XR vision, investing in XR teams or decide to outsource. Filling these information gaps will therefore be the core focus in following projects.

There certainly are technical limitations as well, especially around content creation. Since we also believe that this will have high relevance for future development of XR in industrial cases we would also like to include our reflections around the needs for technical solutions as well.

## Digital Thread – A technological concept

A Digital Thread in the context of XR creation would in theory link the creation tools with the final 3D model (or any other content; text, voice-overs and so on) that is presented in front of e.g. an AR user. This should keep models and information sorted, be easy to update and update on all systems, scenes and devices that are affected by new content being updated. For those familiar with Github this would work similarly but also link CAD with the final XR content. Let's take an example: A CAD user is looking through a 3D file which is the subject for a XR training simulator. She finds a bolt is missing in the component. She corrects the error and presses "commit

change". The VR user can immediately see the 3D model containing the new bolt in VR. This would skip having to export, convert, import and build a new XR application to update  content. This tool only exists as a vision currently and would be a huge undertaking to produce. If successfully implemented it would contribute to easier creation, updating and maintenance of digital models and usher in an era of sustainable XR implementation.

It is possible that Big Data companies, SME:s, 3D communities as well as established tool makers of digital content, and CAD producers, already have similar solutions on their roadmap. Current status on development, weather or not it should be based on AI and how this theoretical tool would be implemented in Swedish industry are just some of the many unknowns. A completely new pre-study would be needed for research to continue on this novel track. For the MAXAT project we focused on, and continue to focus on, the parts concerning information.

## MAXAT 2 – Current information solution

We believe that information from RISE and the XR producing partner companies in the project, byBrick Interface and Panview, will provide a sturdy ground upon which the industrial companies can take strategic decisions about the implementation of XR in their specific company. We will also be able to help XR explorers inside the companies by introducing them to software solutions and information as well as create a vision and a roadmap that will help XR fit into strategic goals of the company and finally define a clear business case.

To accomplish this we will perform a number of workshops and interactive lectures

focused solely on the creation of XR and how it can be practically implemented in each respective company. Below is a brief introduction of the work packages in the coming project:

### Work package 1: More accessible software

In this work package we apply expert eyes to investigate different XR software, how they work and what competence is needed to use them. To showcase these findings we build a VR scene filled with real, industry case 3D models to show how different creation pipelines, tools and 3D styles impact development costs for the industry.

### Work package 2: XR vision methodology

Using the information acquired in WP1 we give industry partners a full set of lectures and workshops. The purpose is to answer the most burning questions about costs and business cases for XR, create a sturdy base for decision-making as well as providing a clear and unified vision for XR that everyone in the company can get behind.

### Work package 3: External communication and orders

We will also aim to produce a practical checklist for collaboration around 3D and industrial CAD. A procedure for preparation and handling of file formats could drastically lower overhead costs in the production of XR when working together with external XR creators. We will also provide industry with a clearer view of the technical limitations developers face when creating XR and help improve communication and order placement in general.

## What happens now

We hope you have enjoyed this reading of the MAXAT pre-study report. As of this writing (April 2019) we are planning the application for the next project. This translates into a two year project with a combined value of 6 milj. SEK. We hope we will be able to continue this research together with the wide range of partners we've been in contact with, in and around, this project, and who have showed their highest interest in our combined progress.

If you have any questions or perhaps would like to join us in upcoming projects please contact:

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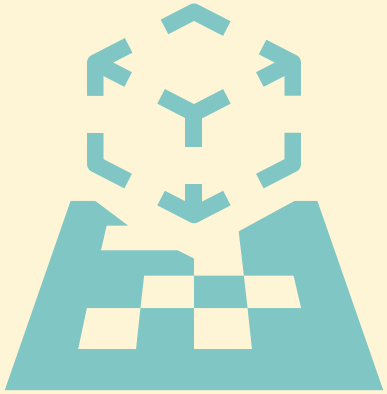
You'll also find more info about the project at:
https://www.ri.se/sv/vad-vi-gor/projekt/maxat-more-accessible-xr-assets-industry



Thank you for reading!