AN **ENLYZE** GUIDE ON MANUFACTURING DATA | 2022

How to get the best production out of any machine

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Summary

Introducion

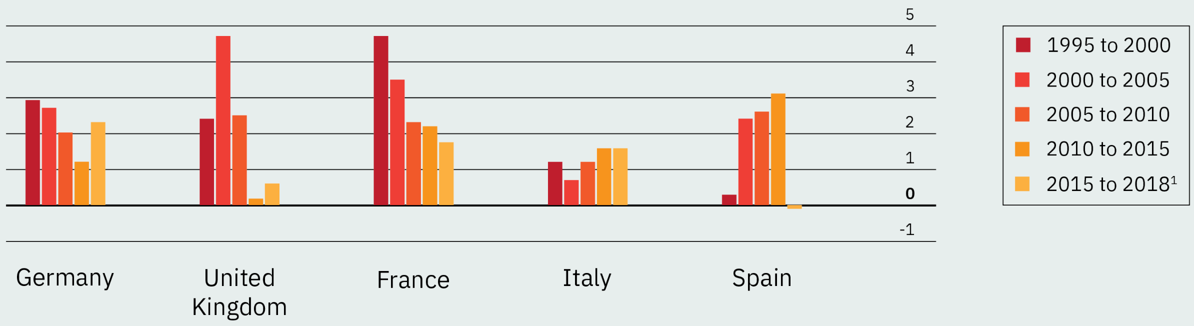
The concept of Industry 4.0 was introduced in 2011 and we would expect that the manufacturing effectivenes in the developed world would have increased significantly by now. But it hasn’t. If we are looking at the labour productivity over time nothing has really changed. This is an unexpected trend and does beg the question how this could be. At the same time, several researchers have published studies on the high failure rate of Industry 4.0 projects.

Our hypothesis is that most vendors jumped on industry 4.0 as a marketing hype and started selling all kinds of digitization projects under the trademark. And digitization in general is awesome, we started getting rid of paper based processes, can streamline how we work with our colleagues asynchronously and our lives have become easier because of it. But this does not directly drive per-capita manufacturing output.

This leads us to the second interpretation that the true industry 4.0 - use cases and best practices for their implementation have yet to be found. At the end of the day, our aim should always be to produce more with less labour input and at a higher sustainability. Given the demographic changes ahead of us and taking the exemplary discussion in Germany about a return to a 42h work week, the importance of reaching this aim becomes ever more evident.

Labor productivity in the manufacturing sector

Average annual change at five-year intervals, in %

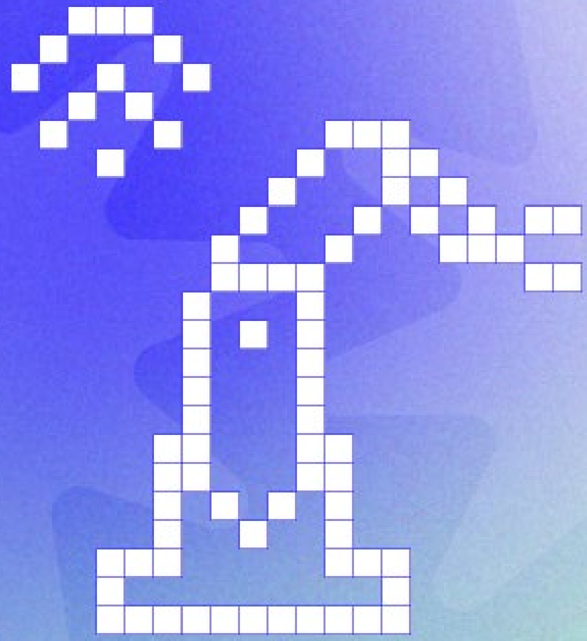


[1] For data reasons, the last interval covers only three years, as no data were available for the comparative countries other than Germany at the editorial deadline.

We've written this eBook in prepartion of the 2022 K Messe and we've collected our experiences of digitizing the world of extrusion over the last four years. This eBook will scrath the surface on relevant questions of digitization in extrusion and related industries:

- How can I digitize my brownfield machinery?
- What should an IIoT Infrastructure look like and what are the important aspects to look out for, espeically in terms of openness?
- What are use cases that improve manufacturing productivity?
- What secondary effects can I expect from my machine data in terms of KPIs, production controlling and forecasting?
- What are some real-life examples of customers successfully working with the ENLYZE solution

We hope you enjoy reading this eBook and we're looking forward to some engaging and challenging discussions on our learnings, your experiences, ideas and needs.



Why do we digitize machinery?

ENLYZE, the company we started in 2018 at RWTH Aachen University, set out to *democratize manufacturing data*. It is our aim, to make manufacturing data - especially machine data - available to all relevant stakeholders so that these experts can gain insights and turn them into action. For this, we have to break up the closed and siloed systems still prevalent in manufacturing.

So, what is it that compelled us to tackle this problem? Being born in the 90s, we are the generation, that was the first to play Mario Kart on our Nintendo64s at night while we were still living in the completely analog world during day time - where you had to remember your best friends' phone numbers to arrange the next sleepover, or simply just walked over there to see if they had already finished their homework and could finally come out to play and annoy our neighbors.

In that sense, we've experienced firsthand how our lives have become more and more *automatized, digitized, and connected* with every year of high school and onwards through university and how we could leverage technology to make our lives easier. Being engineers, we've also noticed how the manufacturing space seemed left out of this trend and got stuck with User Interfaces from the 90s, even worse than that original Mario Kart. We are also the first generation whose default question when faced with a problem is "how can digitization and data-driven methods solve this?"

And we all know, that there are many generational challenges ahead of us and we want to be part of that solution:

- demographic change and worker shortage
- climate change, environmental challenges, and resource scarcity leading to an ever-increasing quest for more efficiency and waste reduction
- automatization of any process, method, or task perceivable.

The possibilities seem endless. Yet, our entire industry is still just laying the (technological) foundation to face these megatrends head-on. To drive change, we need to focus on the low-hanging fruit to keep people engaged, be willing to learn, be willing to fail just to get up again and do better. The benefits of digitization in manufacturing are difficult to communicate but so much more exciting to experience. Let us take you on that journey with us and share some of our thoughts and learnings:

We'll shed some light on a question that continues to baffle us as we've now gotten to know close to 1.000 manufacturing companies: **When are you truly ready for the Industrial Internet of Things?** Watch out though and prepare to be provoked as to why an investment into your ERP system might not be such a smart idea in our opinion.

We're sharing our philosophy on **Recipe Management 4.0** and why we are so bullish about this topic solving many issues related to manufacturing productivity, continuous improvement, and conserving operator knowledge for the next generation of workers.

Do you sometimes feel like things don't add up leaving production management, controlling, and planning living in different worlds? Well, you're not alone and we'll share our perception of the underlying issues and how to tackle them in **Without machine data, your organization lives in darkness**.

Are you tired of dealing with manually updated or distorted OEE figures? Check out our description of how we can automatically derive the OEE and other KPIs from your machine data representing the base truth of manufacturing in **Data-driven assessment of OEE based on machine data**.

Want to learn from some of the mistakes we've made when building or buying your IIoT infrastructure? Check out our summary of the things we'd look out for in **Industrial IoT - Build or Buy**.

Everyone likes dashboards, especially if they are big and shiny to inform operators about what's going on on the shop floor. It's also really easy to do that using Grafana - learn more in **Monitoring Dashboards for Production**.

Ask your automation or electrical engineering team what they most fear when linking your machines to an IoT platform - finding and identifying the relevant 150 parameters out of the thousands a PLC has to offer, renaming and scaling them correctly. We got annoyed by the cumbersomeness and have built tooling with which you can now **Make machine data understandable and human-readable in just a few hours**.

Finally, browse through our last chapter to read of some of our real-live examples and success stories at some of our customers.

CHAPTER 1

Our view of the digital manufacturing world

When are you truly ready for IIoT?

The digitization of manufacturing has been an ongoing hype for 10 years now. However, there is no such thing as THE digitization, as various aspects, processes, systems, etc. in companies need to be digitized. Digitization is also not automatically synonymous with MES, cloud, or AI. This essay clears up the different aspects and is intended to help interested parties determine what they need next on their digitization journey.

How growth comes with a need for digitization

What is the most abstract way to think of a manufacturing company? As a company, you sell your products and source required raw materials to then manufacture said products using your skills and machinery. You then sell more products to more customers, sourcing more material to produce more products on more machines using more skilled workers.

As a manufacturing company grows, the first thing that gets out of hand are the customer relationships. Keeping track of all the contacts and communicating with your customers becomes complex. So the first thing you nned as your sales team grows is a CRM system. As you grow even further and at an ever-quickening pace, your internal processes will gain in complexity, especially when it comes to managing your financials and your controlling procedures. So the second thing you'll get is an ERP System. This will get you really far and as you grow further, you'll add more and more functionality to your ERP: HR and Hiring, Procurement and Supply Chain Management, some first SOPs and other Process Definitions, Quality Management, Warehouse Management, Logistics, etc. Ultimately, your shop floor operations will in some sort or form become part of your ERP System, especially when it comes to production controlling and procurement of raw materials.

With further growth come more machines and more specialized products and you reach the point where your manufacturing complexity becomes a challenge. To maintain your economic edge you'll have to look for a dedicated system to manage all of your shop floor operations. Usually, you'll start out with a production data acquisition (PDA) or a SCADA system to keep better track of all the processes on the shop floor, which will at some point become part of a fully blown ME-/MOM System.

To undertake this step is critical, as the following excerpt will show.

Your ERP is not an all-encompassing system

Selling the ENLYZE Shop Floor BI to manufacturing companies for 4 years now, we've been in touch with over 1 000 prospects of various sizes between 100 and 10 0000 employees and there is one recurring theme that is difficult for us to understand. Companies tend to get stuck at the point where they add more and more functionality to their ERP systems and then they continue doing this and keep on investing in ERP for far too long.

Growth for a manufacturing company comes in phases. You grow to a plateau and then maintain that plateau for some time while you're looking for the next area of growth. And growth then not only comes with more customers and bigger production volumes but always requires gains in efficiency to cope with that growth in demand.

So here's the bummer and the thing we do not understand: the ERP is not your business and by investing in your ERP, your business does not become more efficient. Think about it, you're a manufacturing company so your in the business of producing things. Your actual business happens below the ERP level, on the shop floor. Investing in your ERP makes your overhead a bit easier to manage and you might save some costs by having slightly more seamless hiring and onboarding processes, better financial visibility through an easier application of your controlling principles, or improved warehouse management that enables you to better manage your working capital. But investing in your ERP does not make your business, which is to manufacture stuff, more efficient because your ERP has nothing to do with your shop floor and the ERP has no visibility of the shop floor.

I have Production Data Acquisition and even an MES, so I'm all set, right?

If you have an MES, kudos, you've made it quite far in your digitization journey already. So what happens now? Your paperless production works like a charm, everything seems more harmonized and working hand in hand, planning and allocating production resources becomes easier so scheduled downtimes are far fewer and you receive a bunch of information on occurrences on the shop floor. This is where you will come to think to yourself: hold on a minute, some of these things don't make sense.

The increased visibility in your MES will not only help you to better plan, manage, forecast, calculate and execute your manufacturing operations, but it will also surface a few occurrences in which things do not add up:

- products are not being manufactured as defined in SOPs
- production is not as reliably forecastable and plannable as previously assumed
- quality defects occur not only due to bad raw material
- production times seem to have different realities: pre-calculation, planning, feedback provided in MES terminals, post-calculation and apparently the machinery itself all tell a different story
- your OEE has improved but its still only at around 85% and it is unclear where to look now

So, having reached another efficiency plateau, your next big gains lie in digitizing your machinery, merge all those different realities into one and find those next 10% of OEE increase.

When to reap the benefits of IIoT

IIoT comes in when you've gone through the CRM+ERP maturity stages and have been using some form of PDA or MES in the past. At this stage, you've reaped most of the benefits from an efficient organization, withouth hopefully having gone down the 7-figure ERP upgrade scavanger hunt to nowhere. If you have PDA and continuously receive feedback from the shop floor (i.e. your business) then you'll already know of some of the efficiencies you can gain from IIoT:

- check SOPs and make sure they are up to date while documenting all of your operator experience values
- increase forecasting and calculation accuracy
- identify the 85-95% OEE increase potential
- etc.

The important part is, that IIoT will make your PDA and your MES better and here is how in two examples.

Understanding Downtimes

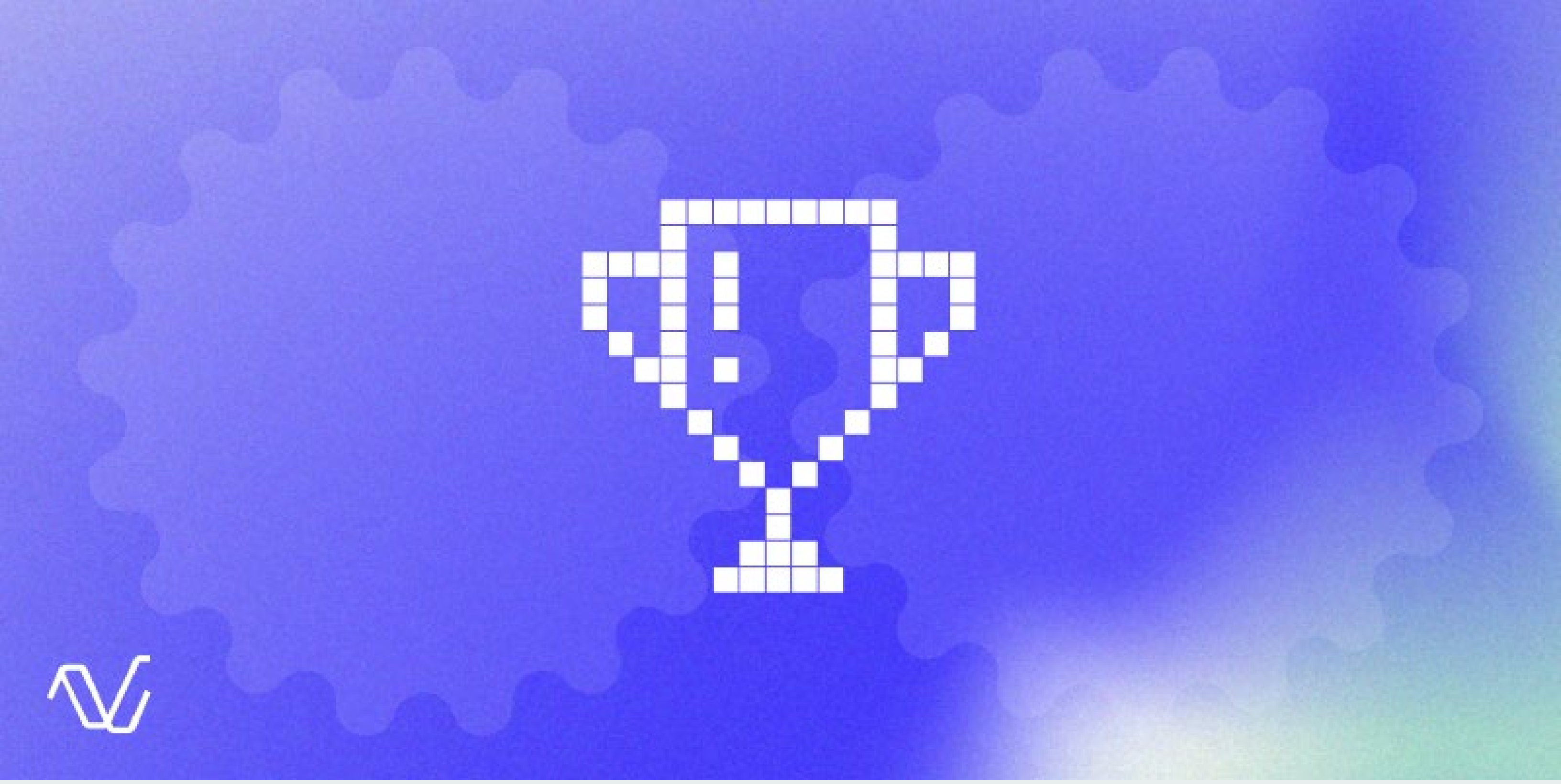
For example when detetermining your down times, your PCA relies on booking information your operators provide in your MES terminals. Needless to say that these manually entered booking data will always be inaccurate and flawed while also being an unproductive task for your workers. If you have and IIoT infrastructure and capture your machine data, you can easily deduce the different machine states with accurate timestamps from that data and feed it into your PCA / MES.

Post-calculation based on manufactured reality

Second, in your post calculation you require a few key data points from your shop floor, such as actual machinery run time as well as total duration of a production order, total material and energy consumption, etc. Wherever that information comes from today and whichever heuristics are used to derive that information, simply using your machine data will always be more accurate and can be automatized as a task as well.

So it is important to think about IIoT, PCA and MES as one integrated set of systems that need flexible interfaces in between them to fully enable each other, grow and adapt to your evolving needs. Obviously doing all three things at the same time would be a huge undertaking and most manufacturers will already have PCA and some form of an MES. In those cases, your task is to rethink these systems and figure out how they can best benefit each other and how IIoT can be used to leverage them for the next level of efficiency gains. If your just starting out, have a PCA and need to decide whether IIoT or MES is your smartest next move, well it depends if you want to focus on improving your organizational procedures for your shop floor first or machine operation itself and start collecting otherwise irrevocably lost machine data (i.e. worker experience values). Whichever you decide, it is important to think of all three components as an eventually integrated system.

Once you start investing into IIoT it is also important to bear in mind that IIoT should not only improve on your current efficiency level but also lay the foundation for future developments. All those mega trends and hypes in the space of machine learning, etc. will eventually require a high-performing, scalable and robust infrastructure with trustworthy and easily accessible manufacturing and machine data - in the cloud and at the edge. So it’s better to embark on that journey with both eyes open and not fall trap to the same ERP upgrade fallacy by chosing the wrong setup today that is inadept to cope with the challenges of the future. Given the longevity nature of manufacturing software a wrong setup today will likely stick around and be patched rather than being replaced when the time would call for it.



Recipe management 4.0

Recipes and recipe management solutions are widely adopted within the extrusion industry. However, our analysis shows: The same product on the same machine is often manufactured using different parameter settings resulting in widely varying throughput rates. This stands in contrast to recipe's intention of being one standardized set of parameters that define how to manufacture a specific product and begs the question: How can it be that recipes exist but the same product is manufactured with varying parametrizations?

Our conversations with prospects and customers have shown that recipes exist but they are hardly used, besides the material specification. So why is so much effort put into the creation and updating of recipes in the first place? How can it be that many other systems such as planning and calculation depend on the recipes but these don't represent the manufactured reality?

We identified three main reasons why recipes are not being used as intended:

- low confidence in the recipes, since they are not continuously adapted and are thus often outdated
- poor usability of the recipes in daily machine operations
- no knowledge about the impact of varying parametrization on overall productivity

The lack of *knowledge about the impact of varying parametrization on overall productivity* proved problematic for us, as we wanted to understand the impact of a solution addressing the challenges of recipe management. So we analyzed the product portfolios of our customers to figure it out.

In total we assessed 7,500 production runs and 1,100 different products. On average, we were able to determine throughput fluctuations of ~4% for the same product on the same machine. **At first glance, this sounds negligibly small, but over time this does boil down to a lost production output equivalent to 12 additional production days per year.**

Low confidence due to outdated recipes

The recipe for a product is usually defined during its early development phase. At this point, the recipe reflects the learnings form the first test runs. Afterwards, the recipes are rarely updated, if ever. This means the experience of the machine operators and operations managers/process engineers gathered over time is not reflected in the recipe.

As a result, the machine operators produce the product better than prescribed in the recipe due to their learnings over the life-time of the product. This leads to a loss of confidence in the recipes and the end up not being used. This obviously has the drawback that productivity becomes a function of worker seniority and experience.

So why are the recipes not kept up to date?

Our customer interviews show this is mainly because of the high manual effort it requires. Data must be combined from different systems, complex analyses must be performed. To make thing worse, the product portfolio comprises several hundred products. Continuous improvement and adjustments in a manual way are hardly feasible. As a result, the recipes are not being updated.

Poor usability

The second issue is the poor usability of the recipes for the machine operator. The recipes have to be consumed at a stressful time with the main objective reaching a stable production process as quickly as possible. Every minute lost during setup and run-in is a minute lost for production.

Let’s look at the process from the machine operator’s point of view. Today, the operating instructions are often created in Excel, printed out and made available to the machine operators on a physical piece of paper.

The operator is confronted with 30-50 parameter specifications. As a first step, he has to get a general overview of the current machine state to then develop a strategy on how to adjust the machine from its current setting to the new product.

To apply the recipe, the individual parameters with their target values must be compared to the actual values on the machine HMI. Sometimes the operator also needs to switch between different views on the HMI to access all parameters. This is obviously not very user friendly and makes it unnecessarily cumbersome for the operators to apply the recipes in day-to-day operation. Just remember the last time you had to compare numbers on a piece of paper with an excel sheet, and now imagine doing this in the shop floor environment.

Running-in a product by experience is therefore less cumbersome, quicker, and often leads to better results. Today's recipe management procedures end up making the lifes of the operators more difficult and complicated and they do not consistently ensure or increase productivity.

Lack of transparency

Third, the lack of transparency with regards to potential gains makes it hard to motivate the team to tackle the problem. To assess the impact during our meta-study we asked ourselves a few simple questions:

- How large is the spread of throughputs over the same product?
- Which share of recipes is outdated and should be updated to reflect the recent learnings from operators and process engineers?
- Which overall productivity gains could be realized?

Even witht the right data analysis tools it took us some time to answer these simple questions. Without the outlook of the potential gains nor ways to track progress it's hard to rally the team behind an improving effort focused on recipe management.

The vicious circle

These three reasons in combination, create a vicious circle that needs to be disrupted:

Recipes are rarely updated and there is limited visibility which recipes justify the high manual effort required for a regular revision. Since the recipes are not updated and don't reflect the latest learnings, the confidence in them decreases. Operators then consequently parameterize the machines based on their experience. Additionally, poor usability makes the usage of recipes cumbersome and further hinders adoption. Closing this vicious loop, operation managers/process engineers lack the incentive to constantly put in the effort to update the recipes as they are not being used to begin with and their potential impact on improving productivity is not tangible

We are convinced that new tools are needed that automate large parts of the processes, thus eliminating manual steps while improving the usability for operators and showing the realized and potential gains on first sight. Only then will recipe management enable significant productivity increases. In addition, recipes are ideal to make continuous improvement processes actionable.

A new way of recipe management

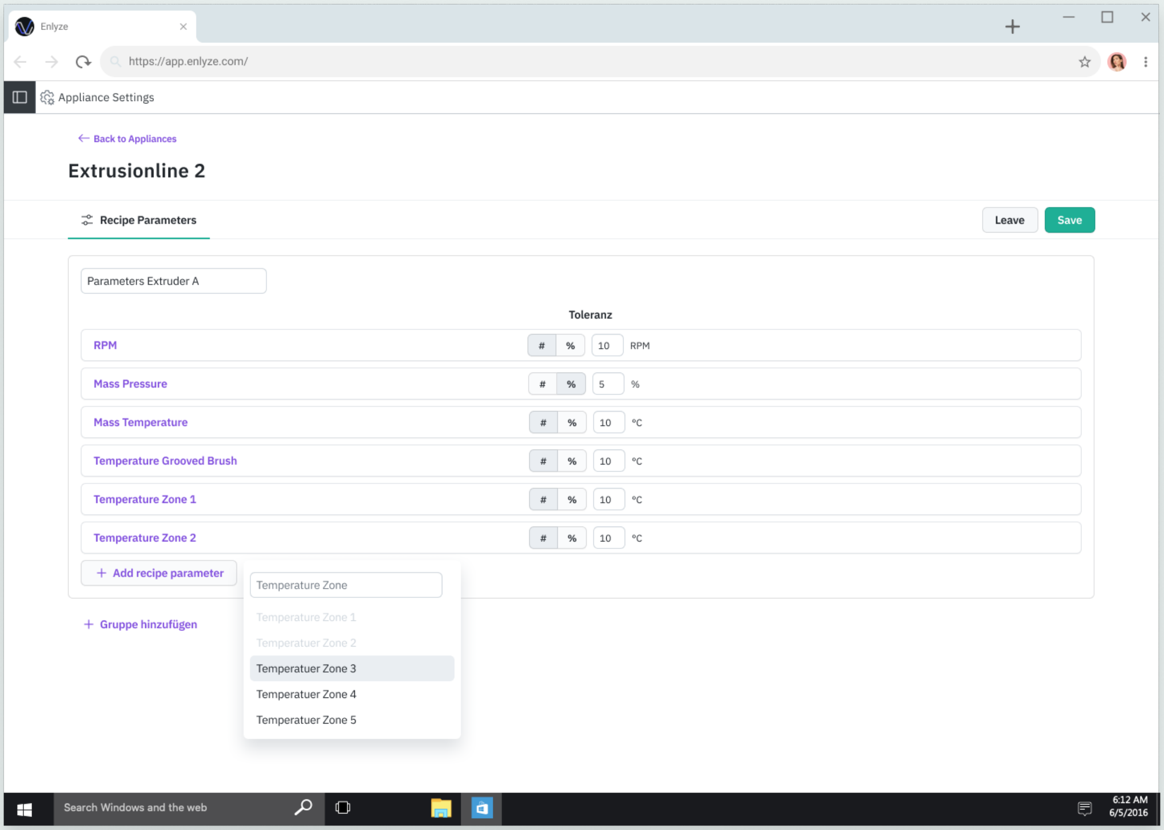
The goal of ENLYZE's recipe management is to provide the ideal recipe for a product at any given time. It is based on continuously recorded machine data that is automatically linked to recipe identifiers (e.g. material codes). We are dramatically reducing the manual effort of creating and maintaining recipes. This approach further ensures that the recipes reflect the manufactured reality.

Three simple steps lead the way along the recipe life-time:

- Step 1. Defining recipe parameters
- Step 2. Creating and using recipes
- Step 3. Managing recipes

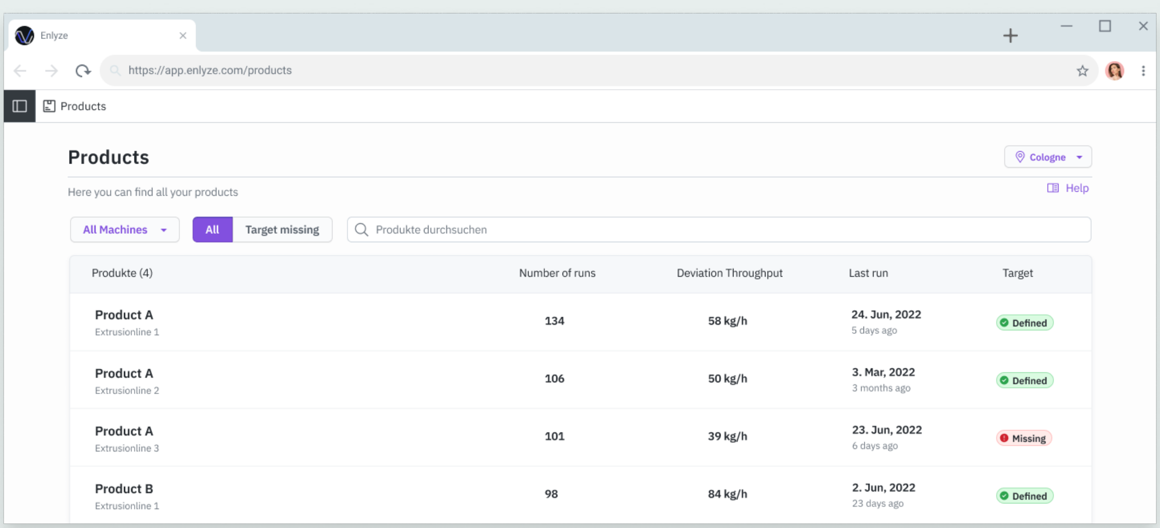
Step 1: Define recipe parameters

At first, the recipe parameters need to be defined for every machine. These recipe parameters are those parameters that the operator controls during the manufacturing process. This step must be performed only once per machine as the configuration is then automatically applied to all products on that machine and can also be adjusted at any later occasion.

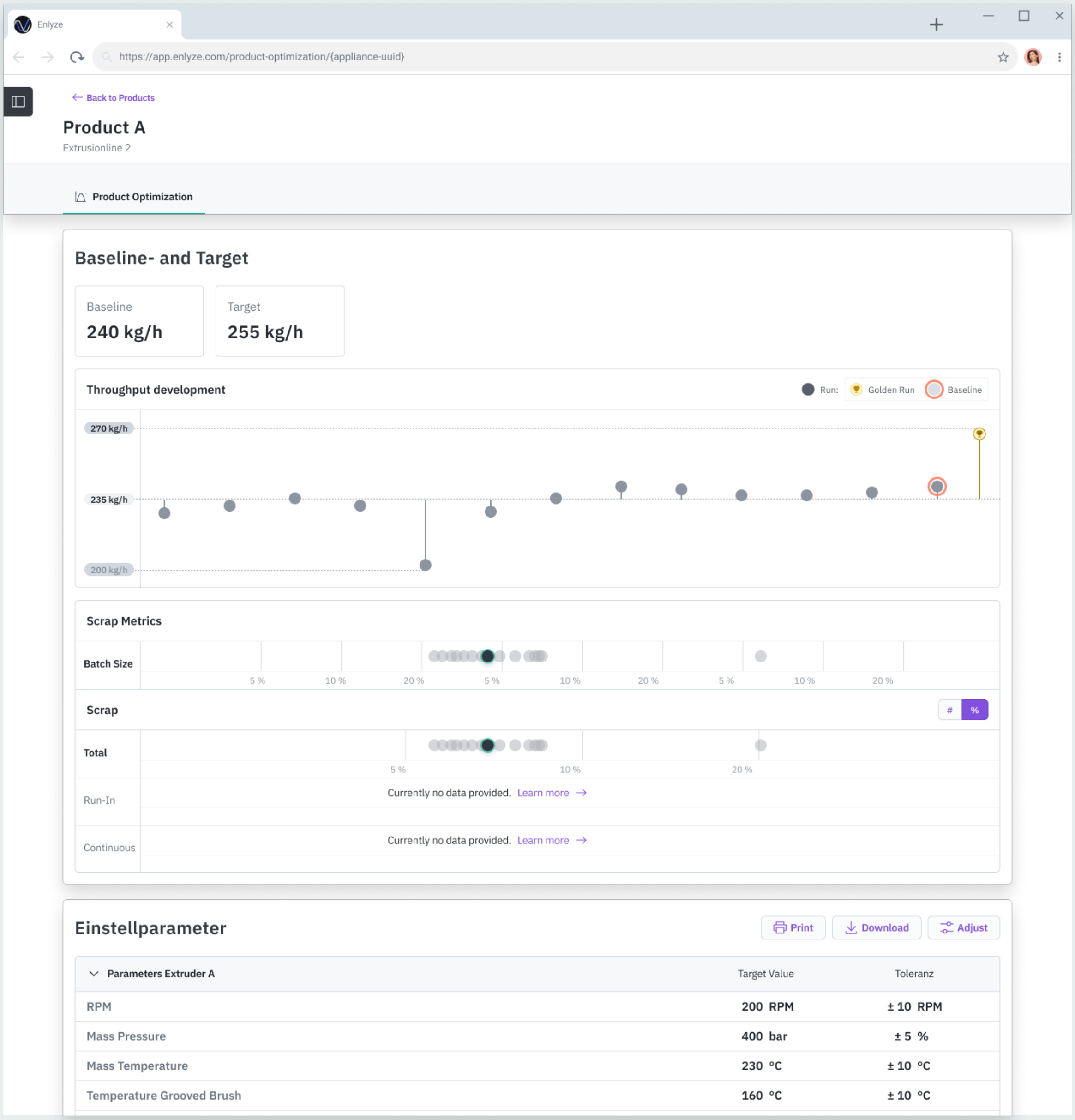


Step 2: Creating and using recipies

Once the recipe paramters are defined, we'll move on to creating the actual recipes. The product overview screen gives an overview of all previously manufactured products. The views can be searched and filtered for easy usability.



Clicking on a product gives access to all production runs of that product.

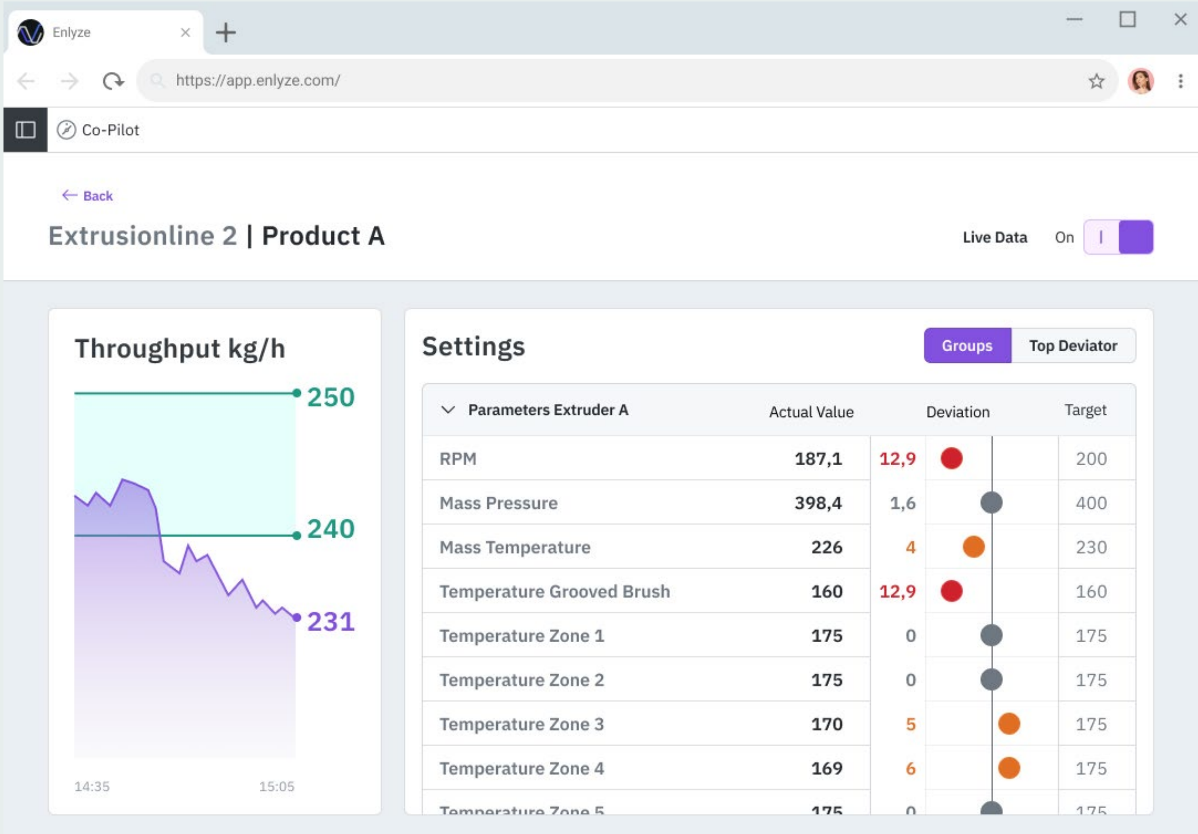


The process engineer view shows the achieved throughput, the order size, and its scrap rate for each production rund. This allows for an easy identification of a reference run based on the achieved productivity. For this reference run ENLYZE now automatically identifes those time spans of stable production within the run and derives the values for the recipe parameters. This way, process engineers simply need to select the correct reference run and the parameters are defined automatically.

The reference run also defines the baseline performance for the respective product.

After the recipe has been defined, operators can access it via the the Co-Pilot interface.

With a single click the operator accesses the combined experience vlaues of his colleagues. He can directly see the baseline throughput value and the best-practice parameters for achieving the productivity. To make the operator's job as easy as possible, the recipe values are compared with the live values from the machine. The parameters with the largest deviations are highlighted so the operator is guided to the necessary adjustment. This visual guidance makes cumbersome comparisons between static values on paper and the HMI screen obsolute. As a side effect, reaction times during process instabailites are reduced greatly, thus having a positive impact on scrap rates.



Step 3: Managing recipes (monitoring & updating)

Having solved the issues of recipe creation and providing the information in an easily digestible format for operators, the remaining issue of transparency needs to be solved.

Which production runs hit the minimum productivity threshold (baseline values), which ones exceed it, which ones do not reach the requirements and why

Which products require an update to their recipes

To solve these issue, ENLYZE constantly monitors all production runs in terms of productivity and deviations from the recipes. In case the baseline performance is missed, the operator will directly receive live notifications to check/adjust the process. Thus, ensuring that problems are uncovered quickly and reaction times are limited. The operator then also has the option to comment on the reasons of the deviations from the baseline (e.g. too high temperatures and cooling was not possible etc.).

Operations managers and process engineers are also informed about those runs which missed the baseline productivity for further analysis of the root-causes. By fostering collaboration between operations manager, process engineers and operators and by providing the necessary information for data-driven discussions, the ENLYZE system systematically helps companies to better understand their production and increase productivity.

To further drive continuous improvement operation managers and process engineers can optionally set performance goals, which are higher than the baseline values. Once the baseline performance is reached and machines are running in a stable mode, operators are encouraged to reach these higher performance goals. Process engineers can thus moderate these productivity increases without playing their hand and risiking higher scrap rates. If such a performance goal would not exist, operators would tend to get stuck at the baseline performance. The valuable experience from the operators to push performance would be lost.

If a product is consistently manufactured above the baseline, this becomes visible in ENLYZE and the baseline can be re-adjusted to the higher productivity level. Recipes will thus stay up to date and incorporate the latest learnings of the operators.

Screenshot home screen and product list with products should be adjusted

Summary and further benefits

There are obvious advantages of the ENLYZE recipe management:

Monitoring ensures recipes are always up-to-date. Through constantly comparing the actually used machine settings to the recipe definitions and automatizing all the data wrangling in the background, we dramatically reduce the manual time and labour that would otherwise be required to perform this task.

Using the ENLYZE system directly results in products being manufactured based on up-to-date recipes and thus helps companies to consistently hit high productivity levels.

Operator knowledge is captured, accessible and is shared with the entire work force for constant improvement. The constant visibililty of productivtiy inspires continuously learn and explore how to improve production. Positive effects directly become visible and can be shared with management and colleagues.

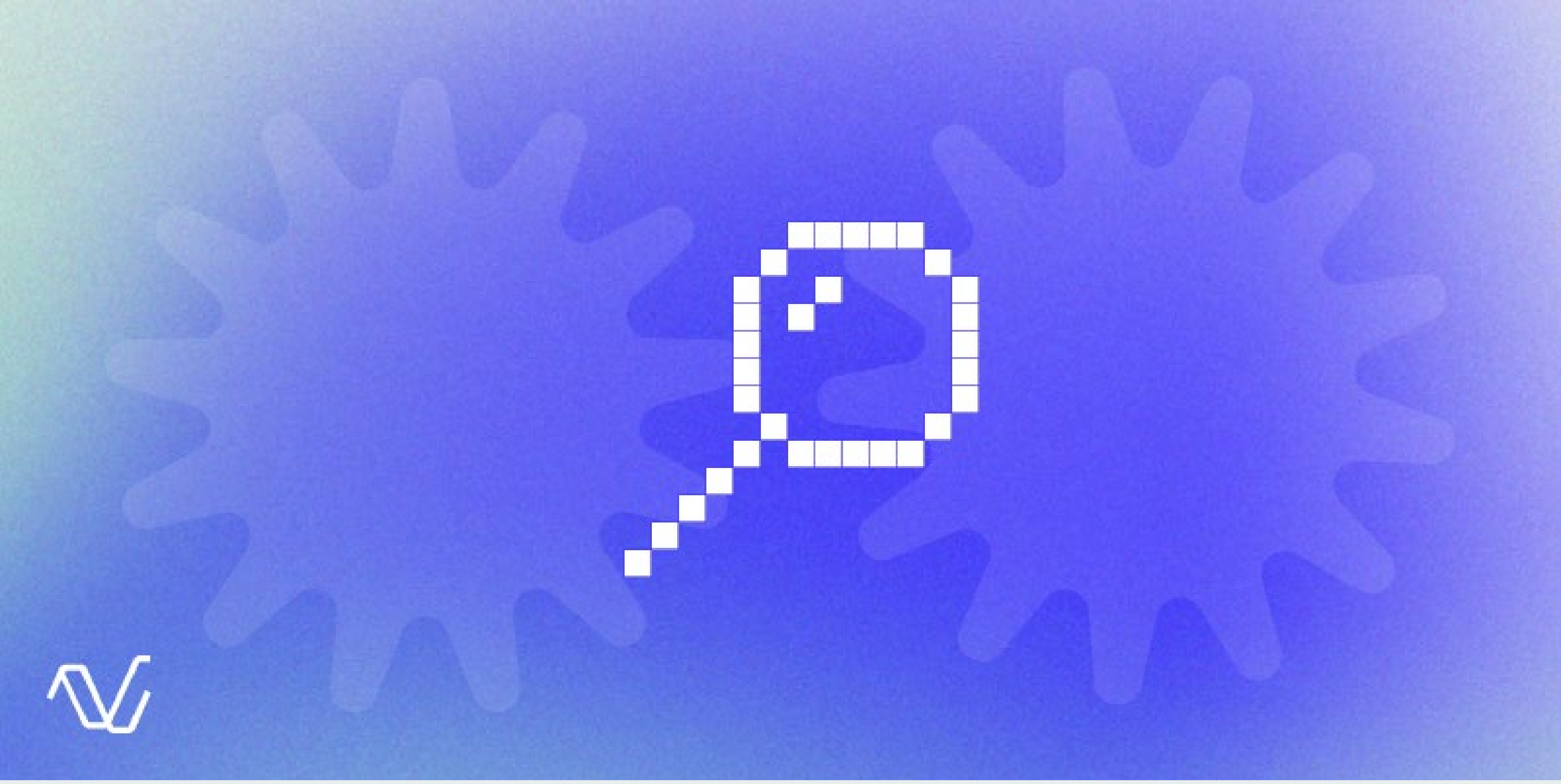
But there are more non-obvious benefits to it. Capturing the process parameters and with those the tacit knowledge of experienced operators, ensures that these experience values are not lost and can be shared with more junior colleagues, should veteran operators leave the company. When looking at the demographic challenges over the next decade this becomes extremely powerful.

Lastly, many functions in the realm of production controlling and planning rely on recipe data for their calculations. Keeping the recipes up to date to reflect the produced reality will help companies to better and more accurately perform their tasks in controlling, planning and forecasting.

Outlook

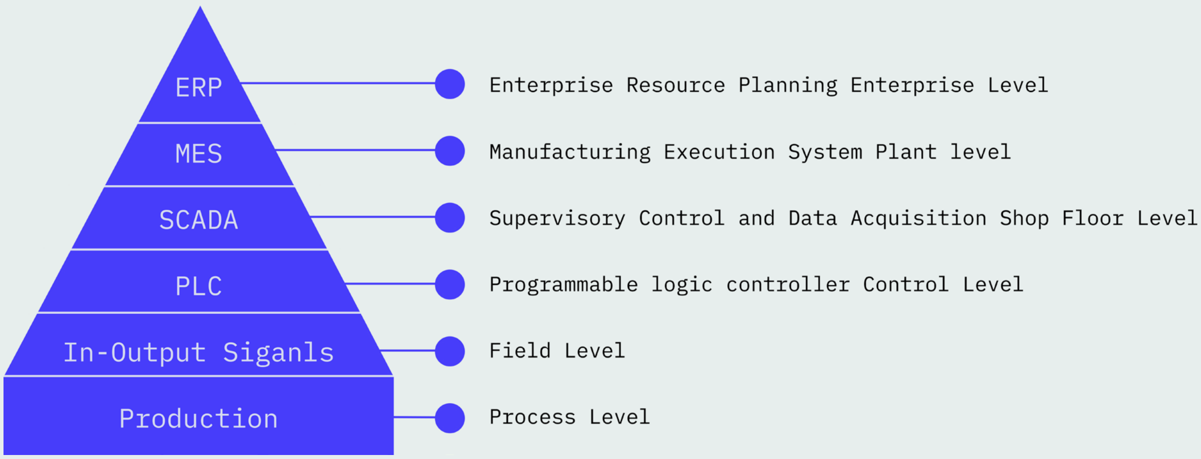
We see that external factors such as temperature, humidity, raw material combinations are also influencing the process. Therefore, the next step is to make the recipes “smart””. Meaning that the recipe automatically adjusts to the current conditions using AI algorithms guaranteeing ideal production result given the current operating conditions.

If this sounds interesting, then get in touch with us and we can exchange on your requirements for such a solution.

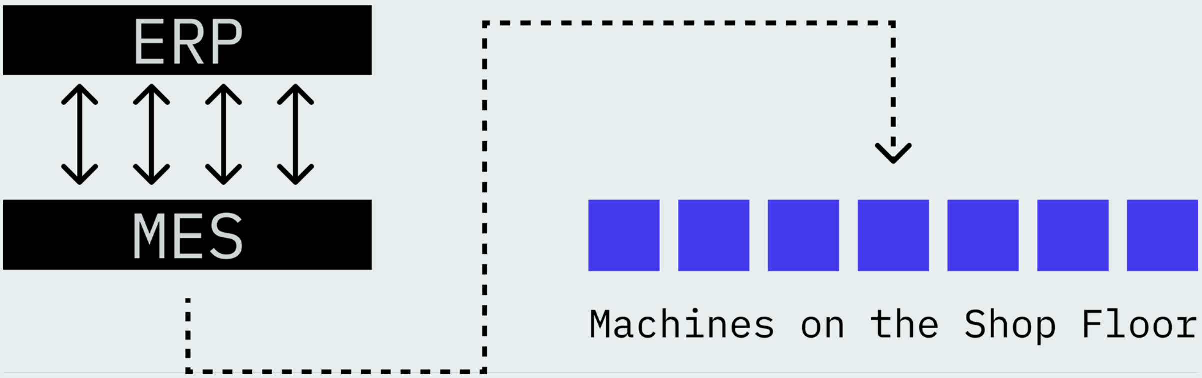


Without machine data, your entire organization lives in darkness

We've all seen these kinds of visualizations depicting our theoretiCal and abstract world of automation perfection. Fully integrated layers spanning from ERP to single machines that share information as needed and aggregating data for different users and use cases.



Well, you can pretty much visit any factory on the planet and will learn that this depiction is a theoretical fantasy. The truth is that ERP and ME Systems are usually closely integrated and exchange their information. But when you look further downwards towards your Shop Floor itself you will notice a presumably insurmountable air gap: all there is are MES terminals for some limited manual inputs from operators and maybe some basic machine data.



ERP and ME are missing the link to the individual machines on the shop floor - these machines form the single atomic units of any manufacturing companies' economic activity. But they do not share their information with higher level systems, leaving production as a black box from the perspective of ERP and ME. This has two major drawbacks:

1. The downward path from ME to the Shop Floor: Standard Operating Procedures (SOPs) are out of touch with reality and (machine) operational knowledge only lives within the minds of individuals

2. The upward patch from Shop Floor to ME: The missing feedback loop upwards into the MES layer creates three different realities (calculated vs. planned vs. produced reality) distorting optimizations on the planning and controlling levels

Outdated SOPs

SOPs should be used to standardize your operations to yield replicable results. When it comes to machine operation though, the reality often is that each and every operator has her own philosophy on how to best manufacture a specific product. SOPs are rendered to become mere guidelines and oftentimes have not been updated in a long time to a changed reality (e.g. different machines, new material types, different work pieces, etc.).

Obviously, as different operators use different machine setups, every operator will reach a different manufacturing output and all the sudden the processes cease to be replicable and harmonized. At the same time, some operators will have found superior ways to manufacture products and this knowledge will be limited to just them. And once the older veterans leave the company, that knowledge and the competitive advantage that comes with this knowledge, is lost for good.

So outdated SOPs jeopardize a manufacturing company's competitive advantage while the variance of machine operation across workers will lead to losses in productivity that could be prevented if companies would harness their machine operators' swarm intelligence.

Lying to yourself

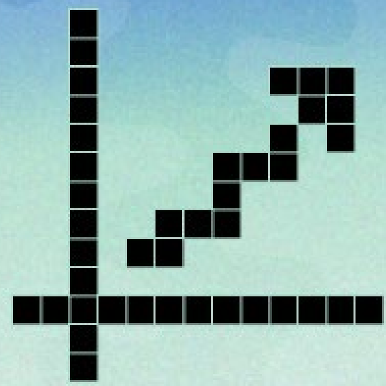
Living in three different and oftentimes conflicting realities should make you question what to believe in. And yet we see manufacturing companies and especially production controllers and planners being faced with this kind of ambiguity, constantly. If their sales teams use a different set of unit economics to calculate their sales margin than they use for calculating and planning production which in the end still does not represent the produced reality and your post calculations reveal different results, this should drive you insane - why even use data in the first place, when it is all off and unreliable? How to even assess which products generate a profit? How should you operate your company when the going gets rough and you need to cut costs? How should you accurately forecast your material demand during supply-chain disruptions with the limited storage space you have? These are just some of the obvious flaws from a missing feedback loop linking your shop floor and your atomic units of economic activity (your machines) to your ME, ERP, SCM, etc. systems and enabling them to share the information your higher level systems require. Otherwise, the amount of visibility for controlling and operational excellence remains limited.

The ENLYZE Shop Floor BI

We've developed the ENLYZE Shop Floor BI to sit right in the middle, closing the air gap between your ME layer and your individual machines on the Shop Floor.

It is designed to understand manufacturing productivity, provide the most accurate, robust and reliable manufacturing KPIs and document and extract operator knowledge from the swarm intelligence of workers. All this information is processed in the ENLYZE Shop Floor BI and is also shared with other systems, such as ME and ERP. This way, we enable a free flow of reliable data through the automation pyramide.

Our customers can better and more accurately plan and calculate their production while they're also improving their overall manufacturing productivity by helping every worker to become the best worker.



Data-driven assessment of OEE based on machine data

Productivity in production is an important factor for the profitability of extrusion companies at all times. Whether it is a matter of achieving the highest possible output quantities in times of high economic activity or of **reducing costs** in times of difficult economic conditions.

In recent years, the OEE (Overall Equipment Effectiveness) has become established as a key figure for measuring productivity in manufacturing. OEE is composed of three factors: **availability, performance and quality**.

OEE = AVAILABILITY * PERFORMANCE * QUALITY

The losses that occur in the individual components of the OEE are also referred to as **availability losses, performance losses and quality losses**.

The OEE ratio puts pure productive time in relation to total time:

$$\text{OEE} = \frac{\text{PRODUCTIVE TIME}}{\text{TOTAL TIME}}$$

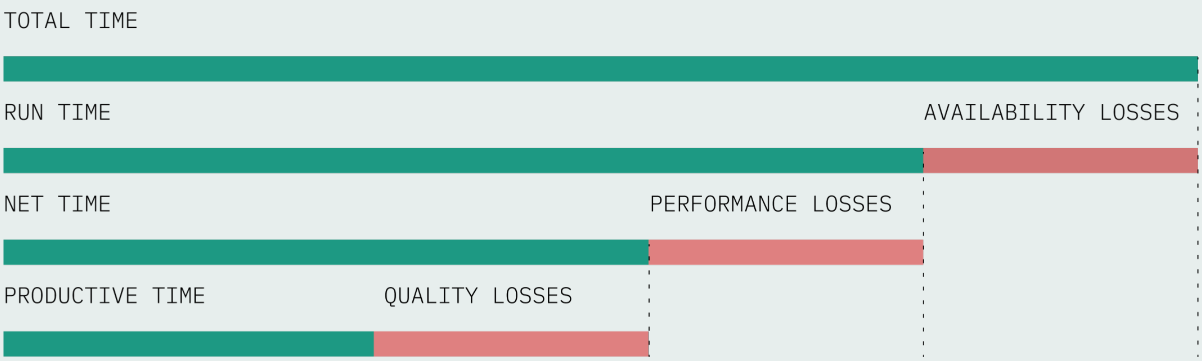


Figure 1: OEE and its loss variables

→ OEE of 100% Manufacturing is running all the time, with maximum speed and without any scrap.

Originally, OEE originated in discontinuous manufacturing, but over time it has been adopted for other manufacturing processes. The success of OEE can be attributed to its ease of interpretation and all-encompassing evaluation of production in a single metric.

In order to uncover concrete improvements, availability, performance and quality losses are broken down even more finely into the “6 Big Losses of Lean Philosophy”.

In the extrusion industry however, we calculate only “5 Big Losses”, since short stops (of less than one minute) cannot occur in continuous production by design. Reasons must also be documented for each lot/loss, and this is ideally done by the workers. Today, feedback from MES/PDA systems is used for this purpose.

	TRADITIONAL 6 BIG LOSSES	5 BIG LOSSES FOR EXTRUSION
AVAILABILITY LOSSES	UNPLANNED SHUTDOWNS	UNPLANNED SHUTDOWNS
	PLANNED SHUTDOWNS	PLANNED SHUTDOWNS
PERFORMANCE LOSSES	SHORT STOPS	REDUCED THROUGHPUT
	SLOW CYCLE TIMES	
QUALITY LOSSES	ONGOING SCRAP	ONGOING SCRAP
	START-UP SCRAP	START-UP SCRAP

Figure 2: The traditional 6 Big Losses vs. the 5 Big Losses for Extrusion

Identify the biggest losses with the “Biggest Loss” analysis

Reasons for unplanned downtime can be, for example, demolition, lack of personnel, lack of material, etc. With the help of the “Biggest Loss” analysis, the causes of losses that lead to the largest losses in total are identified. This identifies the biggest levers for improvement.

With the help of the OEE, the progress of the improvement can then be tracked continuously. This is where the advantage of the OEE comes into play.

→ No matter which loss category is improved, the effect is reflected in the OEE. Management thus has a good tool for setting targets and measuring progress.

A correct data basis is the prerequisite for the implementation of the OEE

The resilience of the OEE metric is very important because it is a key control element for improving production processes. Therefore, the OEE should reflect the actual manufactured reality. A correct and solid data basis is a basic prerequisite for this.

Against this background, it is all the more surprising that most OEE implementations in the extrusion industry are based on manual data collection and calculation.

In the following, we present an automated OEE calculation tailored to extrusion and based on continuously collected machine data.

→ In the following, we present an automated OEE calculation tailored to extrusion and based on continuously collected machine data. The declared goal is to obtain an OEE that automatically captures the manufactured reality for extrusion.

The 3 biggest sources of error in OEE calculation

The 3 main problems in OEE recording for extrusion are:

1. Machine-based performance consideration

2. Manual recording of downtime

3. Manual material recording for calculation of scrap

In the following we will show how these problems can be solved.

1. Machine-based calculation of the performance component

A reference value - the maximum throughput - is needed to determine the performance component of the OEE.

$$\text{PERFORMANCE} = \frac{\text{ACHIEVED THROUGHPUT}}{\text{MAXIMUM THROUGHPUT}}$$

“Maximum machine output” as a source of error

In extrusion, the maximum machine output (machine-based calculation) is typically used for this purpose. However, this approach **neglects the fact that different products can achieve different throughputs.**

→ The solution: Use the production history to calculate the maximum throughput on a product-specific basis.

Therefore, instead of the maximum machine output we recommend using the **maximum throughput based on the manufacturing history** as the reference value (product-based calculation), which has been achieved stably for the respective product. This throughput value is then stored as MDS (Maximum Demonstrated Speed) for the respective product.

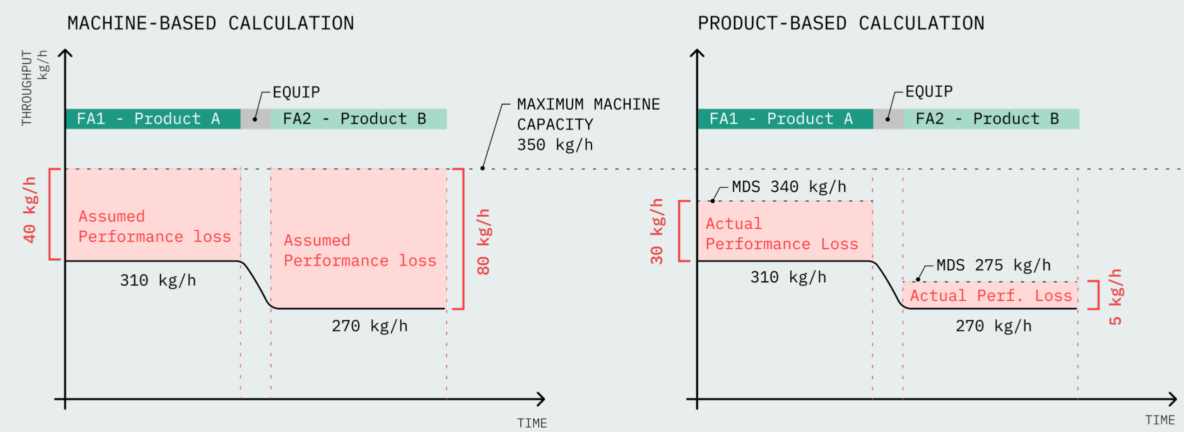
> → The determination of the MDS is carried out fully automatically in the background at ENLYZE and is used for the calculation of the performance component.

Applied to discontinuous production, the MDS corresponds to the ideal cycle time, which is used as a reference value for discontinuous processes. In our opinion, **only this product-related reference makes it possible to make meaningful statements regarding the performance component and thus the OEE.**

The approach of choosing heuristically defined target values as reference values helps to a certain extent, but here, too, the constant comparison with reality is missing, since the reference values change continuously.

Clear differences in precision: machine-related vs. product-related reference value

Figure 3 clearly shows the differences between a machine-based (conventional consideration, left) and a product-based (ENLYZE consideration, right) calculation.



	Performance factor*	
	Machine-based	Product-based
FA 1	88,6 %	91,2 %
FA 2	77,1 %	98,2 %

*Performance factor = $\frac{\text{Throughput kg/h}}{\text{Benchmark kg/h}}$

Figure 3: Machine-based vs. Product-based reference value

In the example shown above, product A can be produced at a maximum of 340 kg/h and product B only at 275kg/h. The max. machine capacity is 350 kg/h. In the conventional approach, the max. machine capacity of

350 kg/h is used as a reference for all products. ENLYZE uses the product-specific reference values (Product A 340 kg/h; Product B 275 kg/h).

Machine-based calculation (conventional):

$$\text{PERFORMANCE FACTOR}_{FA1} = \frac{310\ \text{kg/h}}{350\ \text{kg/h}} = 88{,}6\%$$

$$\text{PERFORMANCE FACTOR}_{FA2} = \frac{270\ \text{kg/h}}{350\ \text{kg/h}} = 77{,}1\%$$

In a machine-based consideration, order FA1 with product A performs significantly better with a performance factor of 88.6% than FA2 with product B with a performance factor of 77.1%.

Product-based calculation (ENLYZE)

$$\text{PERFORMANCE FACTOR}_{FA1} = \frac{310 \text{ kg/h}}{340 \text{ kg/h}} = 91{,}1\%$$

$$\text{PERFORMANCE FACTOR}_{FA2} = \frac{270 \text{ kg/h}}{275 \text{ kg/h}} = 98{,}2\%$$

However, in a product-based consideration, FA2 with product B performs significantly better with 98.2% than FA1 with product A with 91.1% . This shows how large a bias in the performance factor can be with a machine-based compared to a product-based approach.

Inaccuracies of up to 20% with incorrect OEE calculation:

	Machine-based	Product-based	Difference
FA 1 - Product A	88,6%	91,1%	2,5%
FA 2 - Product B	77,1%	98,2%	21,1%

The difference is clearly evident: the differences in the performance component show a difference of over 20 percentage points for FA2. It can be seen that a product-based calculation is worthwhile in order to compare the different products fairly.

2. Manual recording of downtimes is a major source of error.

Another major source of error in the calculation of OEE is the **inaccurate recording of downtimes and their duration**, which leads to an **incorrect availability factor**.

Typically, downtimes are recorded today via manual bookings by the operator in the

MES or PDA system. However, the downtimes and in particular the duration of the downtime are subject to **inaccuracies due to the manual bookings**.

The reason for the inaccuracies is that in the event of a shutdown, the operator first wants to eliminate the problem and get the machine running again. The booking of the standstill and the duration of the standstill usually takes place only afterwards and is only roughly estimated in terms of time. In some cases, paper-based shift logs are still used today, which are only filled in at the end of the shift. Here, entire downtimes are often forgotten.

$$\text{AVAILABILITY} = \frac{\text{PRODUCTIVE TIME}}{\text{TOTAL TIME}}$$

For the calculation of the availability factor of the total loss, the sum of the downtimes is set in relation to the total time. Inaccuracies in the downtimes thus add up and can lead to considerable inaccuracies in the availability factor.

$$\text{AVAILABILITY FACTOR} = \frac{\text{DOWNTIME}}{\text{TOTAL TIME}}$$

Record downtimes automatically

We therefore believe that the recording of downtimes should be automated, without manual bookings, digitally and without pen and paper.

> → Ideally, downtimes should be recorded digitally and automatically and be based on machine data. This is the only way to create a reliable data basis.

Example of automated downtime recording:

Shutdowns can be detected, for example, on the basis of the machine throughput. If the machine throughput falls below a certain limit, then the start of a shutdown is detected. As soon as this limit is exceeded again, the end is detected. This ensures, that the reality produced is derived accurately and automatically from the machine data and at the same time relieves the operator as manual bookings are no longer necessary. In addition, the operator can directly correct the problem at the time of the shutdown and can specify the reason for the shutdown afterwards: A win-win situation.

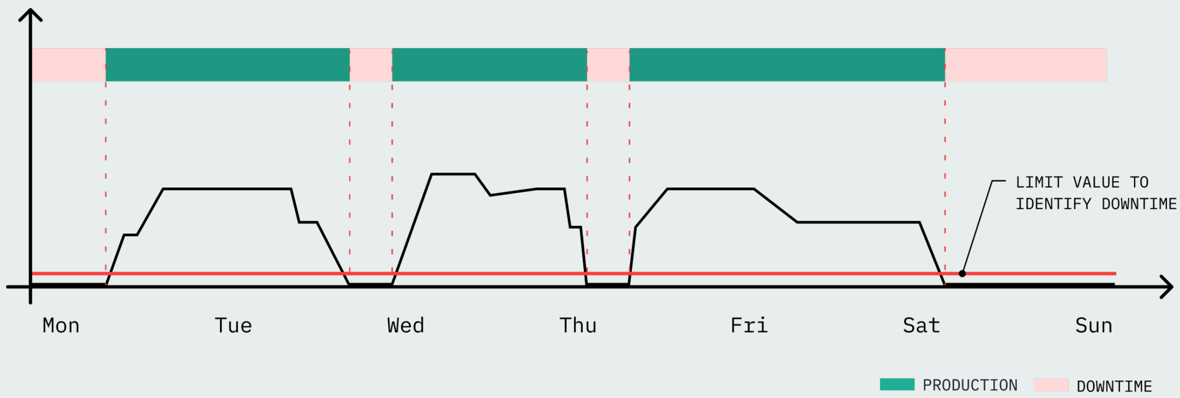


Figure 4: Automatic recording of downtimes using a limit value

The recorded shutdowns and the reasons for them can then be used in a subsequent “5 Big Losses” analysis to identify the biggest levers for avoiding shutdowns.

3. Inaccurate material recording

After a correct recording of the performance factor via product-based benchmarks as well as an exact and automated time recording of downtimes for the availability factor, the quality factor still remains as the last open component.

To calculate the quality factor of a production order, the scrap quantity must be set in relation to the total plasticized quantity.

The exact determination of the yield often poses no problems in practice. For this purpose, the quantity of material is usually weighed or recorded in linear meters or other quantities and booked into the ERP/MES system. Blocked quantities are subsequently taken into account by QA in these postings. It is more difficult to record the plasticized quantity or the scrap.

The plasticized quantity can usually be determined via the throughput (e.g. from gravimetry). For this purpose, an integral is formed over the throughput, with the limits being the start and the end of the respective booked order. By subtracting the yield from the plasticized quantity, the scrap quantity is calculated. The quality factor can then be calculated.

$$\text{QUALITY FACTOR} = \frac{\text{SCRAP}}{\text{PLASTICIZED QUANTITY}}$$

Summary

The objective was to present an OEE determination method that **reflects the *manufactured reality* in extrusion** in order to make data-based, targeted decisions to increase productivity.

Much of the data collection can be automated. However, the start and end of a job must still be done manually. However, errors caused by manual postings are drastically reduced.

Accurate OEE calculation is ensured by:

- **Product-based reference values** for the performance calculation.
- **Accurate and automated recording of downtimes** based on machine data
- The evaluation of the quality factor, based on the automatically recorded plasticized quantity
- In this way the OEE represents the actual manufactured reality and can be used meaningfully to control production.
- In addition, there are further advantages to be gained from automated recording of the OEE:
- Continuous availability of key figures without manual input need
- Building trust in the database

Significant reduction of the effort required to maintain the system

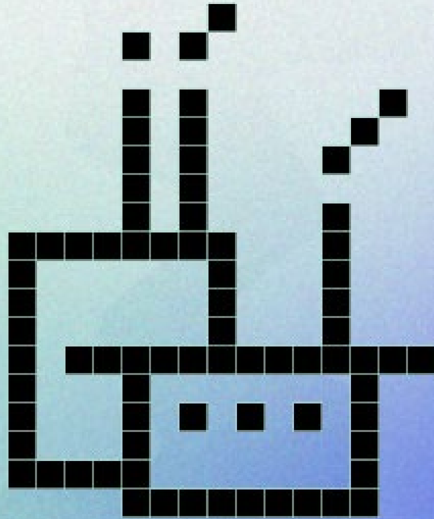
→ ENLYZE has tested this method of determining OEE with five extrusion companies over the last year in operational practice and has constantly developed it further.

In the meantime, almost 15 customers are successfully using ENLYZE's OEE tools. On average, the companies have been able to increase productivity by 3.6% in the first 3 months with this data-driven approach and increase their productivity by 5-20% in the long term.

In addition to the OEE calculations, ENLYZE also provides the appropriate analysis tools to perform root cause analysis on productivity losses. The first product features of ENLYZE Shop Floor BI are targeted at production, plant and operations managers as well as lean and operational excellence managers.

CHAPTER 2

IIoT technologies and stumbling blocks



Industrial IoT - build or buy?

Introduction

By now, it has become common wisdom that the Industrial Internet of Things (IIoT) is one of the key enablers for a manufacturing company's digital transformation. Acting as the foundation for data driven applications, advanced analytics and AI, getting IIoT infrastructure "right" is mission critical and pays dividends in the long run.

Behind that backdrop, digital change leaders are facing a pivotal decision of whether to build or buy such infrastructure, where evaluation vectors evolve around granularity of control, data access and governance as well as extensibility.

The following aim to shed some light on some of the key questions digital transformation leaders may want to consider when thinking about building or buying IIoT infrastructure.

Do you have the talent readily available?

In order to successfully develop and implement your own IIoT infrastructure, depending on your needs and what you want to build in-house, you will need to assemble a cross-functional team with a diverse skill set reaching from embedded hard- and software, backend, and systems engineering as well as DevOps.

With the primary value driver of manufacturing companies being the production and sale of goods and not tech, manufacturing companies might lack the relevant talent in-house. More so, the extremely competitive tech hiring market and traditionally low salary brackets for IT staff (read more [here](https://blog.pragmaticengineer.com/software-engineering-salaries-in-the-netherlands-and-europe/)) makes it hard for manufacturing companies to attract and acquire the necessary talent.

Even if you have a significant budget at your disposal, needing to hire the team first might set you back 12-18 months - and that's before you have even gotten started.

How much control do you want?

This is a topic that is discussed not too often and deserves more attention. As always, there are many ways to achieve the same outcome, and building up your IIoT infrastructure isn't any different. In broad terms, three themes exist:

- Building everything from scratch using readily available open source technologies (bricks)
- Making use of technology building blocks such as Kepware, Azure IoTHub etc. and gluing it all together, often with the help of external partners (building blocks)
- Outsourcing the IIoT infrastructure to a third party such as Cognite, SightMachine, ENLYZE and alike (Platform as a Service)

From first to last, the amount of technology that is built, maintained, and evolved in-house is decreasing continuously, which comes with its up- and downsides.

When building everything out of technology bricks in-house, you have full control over the road map and can tailor to your organization's specialized needs. No third-party solution comes with this level of control - not even if you are the vendor's most important customer.

Oftentimes, manufacturing companies using Kepware, Azure IoTHub and other building blocks cooperate with solutions partners such as Accenture, Capgemini, or other technology consultants to design and implement their IIoT infrastructure. One of the great advantages of this approach is that these companies come with significant experience and past lessons learned and present a viable partner to help guide the digital transformation journey. On the downside, 1st tier consultancies charge high fees and their cost structure demands big, costly projects that make them financially unattractive for many small and mid-sized companies. What's more, time to value increases significantly since consultancies present an additional organizational layer of indirection.

Lastly, third-party IIoT infrastructure is sufficiently generic to serve a large customer base. Thus, chances are that highly specialized, niche use cases or certain functionality may not be implemented or generally available. However, oftentimes, they ship with plugin systems, APIs, and no-code integrations that can be instrumented to implement custom use cases, giving you the best of both worlds.

Cost wise, third party IIoT services such as Cognite, SightMachine or ENLYZE charge subscription fees, which may represent a novel approach depending on the organization. Even though these fees are charged perpetually from the date of purchase, they are well below the cost of employing an entire in-house team to build, maintain and evolve a proprietary infrastructure.

Do you have the time and budget?

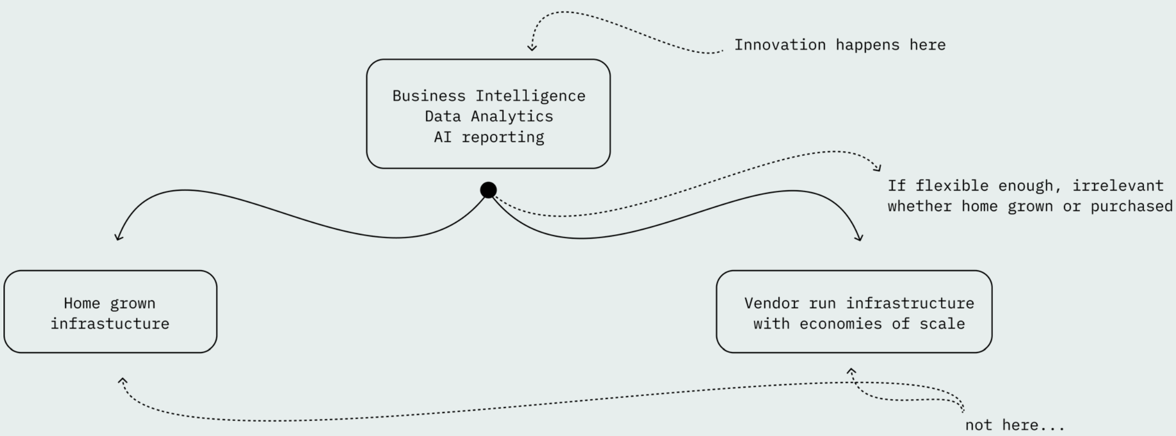
Building a secure, scalable and usable IIoT infrastructure should not be underestimated. Depending on which build strategy you follow (brick or building block), your team will need to cover a lot of ground:

- Retrofitting and potentially reverse engineering brownfield machinery. This gets especially time intensive when you are dealing with a heterogeneous machine parks.
- Procuring, provisioning, installing, managing, and monitoring edge devices
- Building in Over The Air updates (OTA) for your devices so that they can be updated remotely - modern engineering teams work iteratively. You don't want to go around plugging in flash drives into every device every day or so
- Capturing and publishing data into (hybrid) cloud or on-premise systems
- If you want to stay on-premise, you might need to invest in a new server infrastructure
- Setting up a secure telemetry infrastructure such as MQTT, RabbitMQ or Kafka, proper authentication and authorization mechanisms
- Building in data buffering and persistence every step of the way to minimize data loss
- Building data pipelines, storing and processing data, and making it available for apps
- Building integrations into 3rd party systems (ERP, MES, Quality Systems)
- Normalizing data from different machinery into a unified namespace (your digital twin of every machine)

Before you can hit the ground running, you might need to invest 5-10 years of cumulated engineering effort to build your infrastructure, which can easily translate to 6-18 months project delay. And even if you have successfully shipped v1.0 and feel excited about moving on to delivering business value, your infrastructure needs to be maintained, new requirements need to be turned into functional features, bugs need to be fixed and the infrastructure needs to be kept up and running. This will capture 20-50% of your team's capacity and should not be left out of consideration.

What is core to your initiative?

From our perspective, the most important consideration by far is what is core to your initiative. No one is considering to build or buy an IIoT infrastructure without being member of an initiative with a specific goal in mind. Most often, goals of initiatives are to deliver business outcomes and naturally, are focused around the domain of production, sales or other existing departments of a manufacturing company. “We are in the business of producing and selling XYZ - not making software” is a statement we have heard countless times in the past few months.



As part of such an initiative, your primary objective is to deliver on the business outcome as quickly and efficiently as possible. As outlined above, shipping v1.0 of your infrastructure takes considerable effort and might leave you waiting 6 - 18 months before being able to start solving business problems. This is where the buy track really shines: Buying off the shelf IIoT infrastructure enables to start working towards your initiative goal right away and thus significantly reduces time to value.

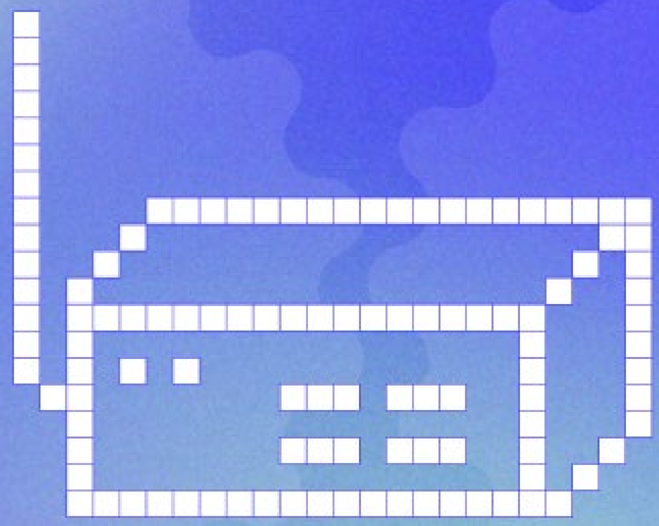
Closing thoughts

Understanding the trade-offs for your organization and making an informed build or buy decision for your IIoT infrastructure can be a make it or break it point in your digital transformation journey. While this post presented a couple of perspectives to consider, every organization is different and you will need to understand your unique constraints and abilities. There are points for both and ultimately, it depends on your strategy, goals, in-house expertise and budget which one makes sense for you.

That being said, many manufacturing companies are just at the start of their digital transformation journey and digital initiative leaders find themselves pressured to deliver outcomes as quickly as possible. Paired with constrained resources and a talent pool that is optimized for a different skill set, 3rd party solutions offer a highly customizable drop-in alternative that cut time to value significantly, allowing to create success moments, visibility, and gain executive buy-in far quicker than focusing on building up your own infrastructure first.

At ENLYZE, we are building the next generation IIoT platform that is highly specialized for the continuous manufacturing industry, while cutting time to value short with a high-value use case of product based productivity tracking and Standard Operating Procedures (SOPs).

Whether you are just getting started with your digital transformation or are in the midst of finishing your first big milestone, we would love to hear about your personal story and see how we can help. You can reach us via hello@enlyze.com.



Monitoring dashboards for production

How you can use Grafana to build your own production dashboards to run machines more efficiently.

Imagine you are responsible for a product that is produced with a new material combination and you need to follow the process closely to see if everything is working fine. Or you are in charge of keeping multiple machines running at the same time and need a quick overview of each machine. Or maybe you don't want to constantly check the production dashboard but want to receive a notification once a critical threshold is crossed. All of these scenarios require process monitoring and all of it can be done using Grafana.

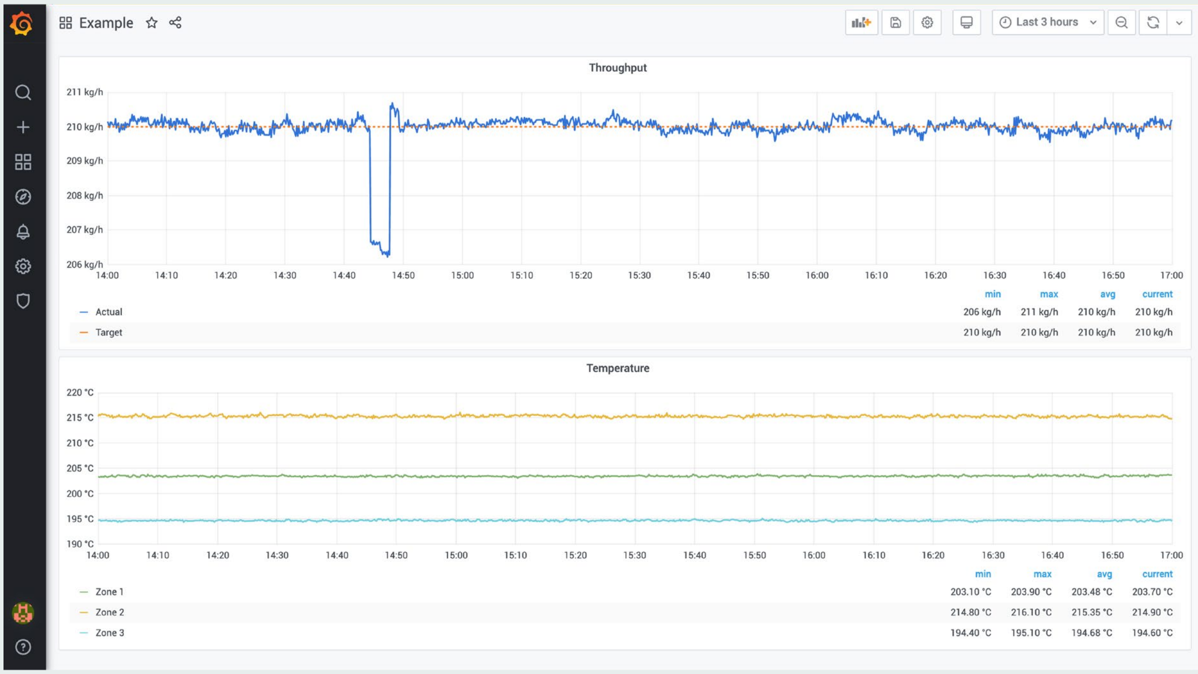
> Process monitoring not only increases visibility but enables to react quickly to deteriorating, or unusual operations and ultimately ensures that machines run more efficiently.

We are using Grafana for internal process monitoring and as a pre-configured dashboard for our customers that comes out of the box. But the real power of Grafana is that it is highly configurable and can be tailored to many different and specific use cases. This also comes as a huge advantage when monitoring goals change over time. Once you observe a process in real-time, you quickly generate new insights about it. Using the prowess of Grafana, it is a great advantage to be able to quickly iterate in the visualization layer and incorporate those learnings. In this article, we provide an overview of the three most common monitoring use cases and how Grafana can be used to implement them.

1. Process monitoring over time

With Grafana, time series data can be displayed very quickly. Any number of variables can be displayed and a variety of configurations are available (see these showcases for examples: Showcase 1; Showcase 2). Units scale dynamically for better usability and a more intuitive interaction with the data. A particularly neat feature is the possibility to perform further data transformations or calculations via the advanced queries option, such as derived variables, machine state detection based on criteria derived from machine data, an indication of set point changes, etc.

The displayed time period can be set in different ways. Here in the example, the data for the last 3 hours is always displayed. The visualization continuously refreshes itself automatically so that it always displays the latest live data. Alternatively, individual time periods and historic time frames can be displayed with just two clicks. But also larger periods can be displayed without any problems.



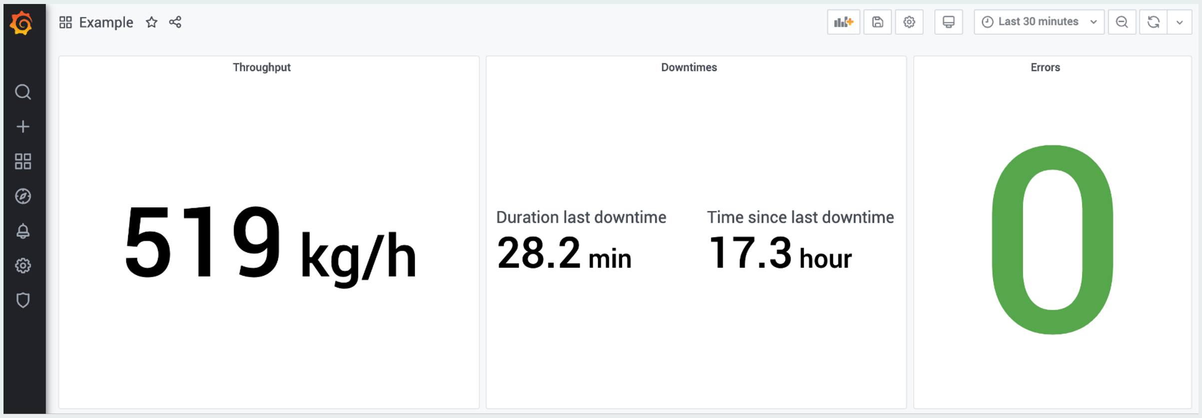
With some basic configurations, you can build a dashboard with which you can monitor and analyze your process over time. You can build plots to see how changes in target variables influence other variables and analyze what exactly happened just before a problem in the process occurred.

Being able to observe a variable over long time periods can also help to identify problems that develop slowly over time and are not obvious at first. An example of this is the slow clogging of a filter. The resulting pressure in the machine increases slowly over time and this trend only becomes clear when observing a large period of time.

2. Quick overview of key metrics

The second use case is a monitoring screen showing the key KPIs of the shop floor operations to shift leaders and operators. As not every machine can be attended to all the time, keeping an overview of the different machines in operation is hard. It is, therefore, all the more important to quickly assess which machines need to focused on and which machines are currently running smoothly. Monitoring dashboards (Gemba Boards) on the shop floor are suitable for this and can easily be implemented using Grafana. The relevant KPIs can be displayed in large numbers with colorings based on threshold values to guide the observers visually and provide more context.

Since the dashboard is updated regularly (for example once per second), the current status is always present. Data from multiple data sources and machines can be combined in one dashboard and complex queries can be used to calculate high-level production KPIs. An example of this is shown in the screenshot below. Next to the current throughput (performance) of the machine, the duration and the time since the last downtime are displayed. The calculation of these exemplary KPIs is done within Grafana and uses the throughput variable as a basis. On the right side, the current error rate is displayed, which is provided by an online quality measurement.



Using a dashboard like this on your shop floor, possibly combining KPIs from multiple machines, increases transparency, improves the response times to errors and ultimately leads to higher throughput and better quality. As a side effect, we've seen our customers' shop floor employees engage in more meaningful discussions once the data driven visibility of the machines operation is live. All the sudden they start discussing more about process anomalies, observtions, typical machine behaviour and best-practices on how to deal with specific issues. This kind of knowledge exchange was not present at our customers before they had these monitoring dashboards.

> ”We can view important process parameters on the shop floor at a glance and at any time. Their representation is easily digestible and comprehensible. The displays have helped us improve the visibility of shop floor operations, brought down reaction times and fostered collaboration within our work force.”
>
> Alexander Kaunath, Betriebsleiter DUO PLAST AG

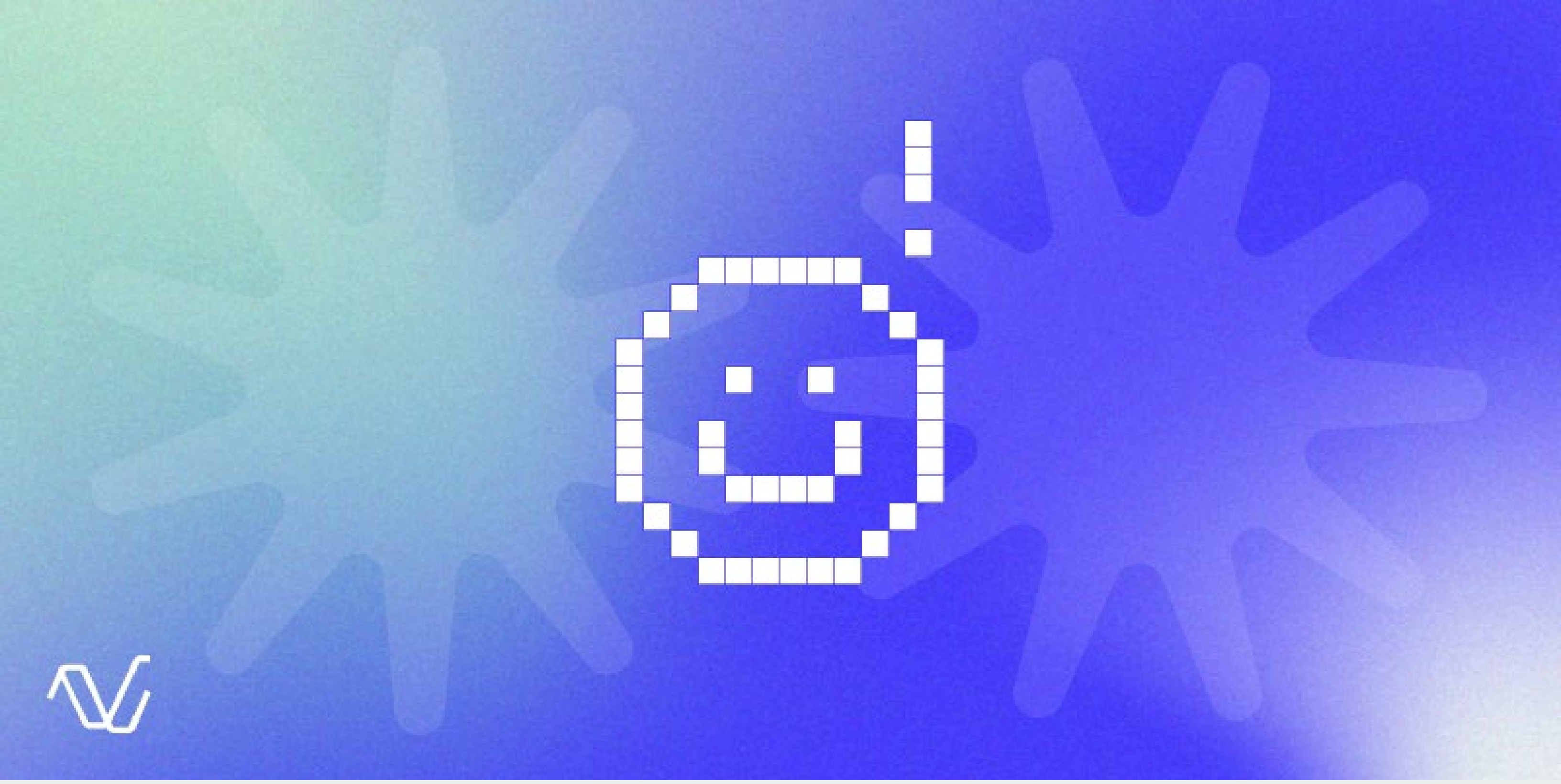
3. Alarming and push notifications

The third exemplary use-case concerns alarms and push notifications. Grafana comes with a built-in alert function that can publish the alerts to a variety of channels. What we like best about the built-in alert function is its flexibility, configurability and ease of implementation. Alerting rules can include lower or upper limits or values within certain ranges for a specific duration. More complex alarms can be defined using queries, providing close to unlimited possibilities. Once an alert rule is defined, it can be used within the dashboard alone (e.g. indication via colors) or to publish messages to a notification channel. Several different integrations are available among which the integration to Microsoft Teams is the most frequently used by us.

Setting up an integration to MS Teams is fairly simple, it only requires a channel with an incoming webhook. We recommend setting up a separate channel for the notifications so that the notifications do not interfere with the flow of other conversations. Interested users can then join that channel and receive the notification directly in their well-known work environment. Integrations in Slack, Telegram, or via email are also possible.

We have built alerts and push notifications for a variety of use cases. They range from preventive purposes, such as the early detection of pressure increases or temperature changes in the cooling system, the detection of critical events or phases, and also production state monitoring of machines.

We hope this article gave you a good first impression of the different monitoring use cases and how to use Grafana to implement them. All three combined form a strong foundation to continuously monitor and improve production. We're happy to discuss your specific use cases and needs and how an implementation is possible.



Making machine data understandable to people – in just a few hours

Today's technology makes it possible to access process data from machines and the machine periphery. But simply recording and storing data is not enough to generate value. In order to use machine data meaningfully, it must first be prepared in such a way that everyone can understand what the respective data point represents in the real world.

To make data understandable, it must be provided with context – that is, information that describes the data. We refer to this process as **contextualization**.

In this article, we provide insight into how exactly these tools **work**, why digitization projects **become easier and faster to execute** through such an approach – and what the process looks like in detail.

End-to-end solution for data contextualization and analysis

At ENLYZE, we have developed tools that make it possible to acquire new data points from any PLC or industrial PC and add context to them within minutes. This way, new machine data points can be **added** to the ENLYZE platform, relevant **context can be attached** to the data, **and the data can be used for analysis and in dashboards**.

We have paid particular attention to ensuring that our users can perform this process on their own and **do not require external or internal IT specialists**.

This approach offers tremendous advantages: The system can be continuously adapted to changing requirements. Because each user and process expert can make the changes independently, adaptations to the analysis dashboards are almost instantaneous. By moving process experts into the center and cutting dependencies on IT departments, **the user's motivation and adoption increase as everyone is empowered to work independently**. Manufacturing anomalies and problems can thus be solved in a data-driven and efficient way.

Why are so few manufacturing companies digitized

Digitizing machines poses two major challenges:

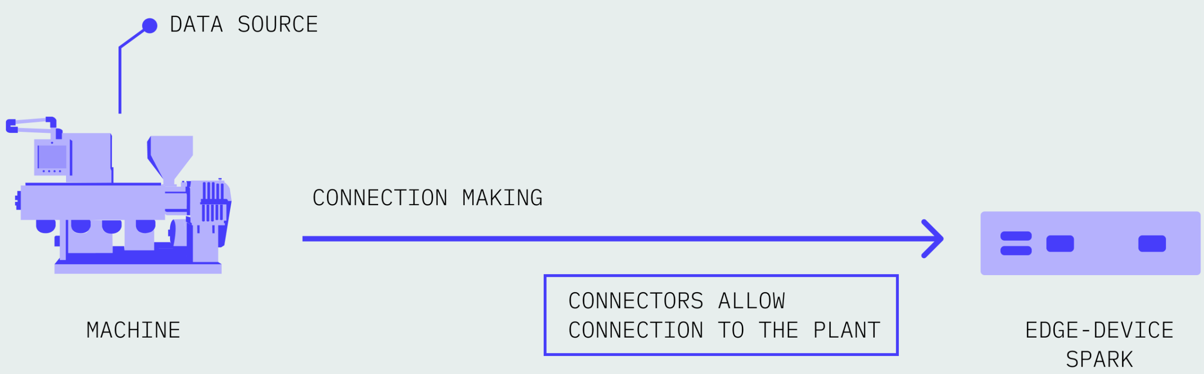
1. **Reading the data** from the machines

2. **Processing** the data to make it usable

Reading out the data usually requires a combination of software and hardware. The hardware establishes the physical connection to the machine and the software acts as a translator for the respective communication protocol of the machine.

More on this topic and how we solve the problem with our edge device SPARK can be found in this article.

Once the physical connection and the appropriate protocol are in place, data can be read from the machine. The problem regarding reading out the data is thus solved.



Prepare data to make it usable for everyone

The data were originally only intended to be used internally by the machine itself and therefore often have cryptic designations. Often the designation of the data points consists only of a few letters and numerical values.

Thus, the data points cannot be easily interpreted by a human. For this, the data points must first be "*translated*".

We call this "*translation*" **contextualization**. In this process, the data point is given an understandable name.

For example, the internal tag on the PLC Temp_regler_01_K1_03Temp_regler_01_K1_03Ist Temperatur Heizzone 1 is translated to Actual Temperature Heating Zone 1. How exactly we arrive at this translation is clarified later in the text.

In addition, the data point is assigned a unit. In this example it is a temperature, therefore °C°C is chosen. If necessary, the value can also be scaled. This will also be explained in detail later. After this information has been added to the data point, it is contextualized.

Only by adding the context, the data point, and what it represents is understood by everyone. This makes the data easily accessible to all users and anyone from production to controlling can use the data point for analysis or in dashboards.

CONTEXTUALIZATION
ALLOWS EASY HANDLING
OF THE DATA

The traditional approach of other vendors

Previously, contextualization was **costly and time-consuming** as knowledge from two different areas is needed. On the one hand, **expert knowledge about the machine and the process** is needed to correctly interpret the data, on the other hand, the IT **knowledge** is needed to establish the connection to the machines, to attach the context to the data points, and to store these data points permanently.

Today, the task is usually performed by engineering firms or automation technicians. As a rule, an implementation by external service providers takes 5-10 working days and costs accordingly.

However, with this traditional approach, there is a lot of friction between the process engineers and the IT experts involved.

The process engineers have to identify the data points that are needed and communicate them to the IT experts. Once the IT has found all the data points, they need to be validated together with the process engineers. After successful validation, the data points are then permanently stored in a system by the IT experts.

The entire process, from selection and validation to permanent storage, therefore requires at least two departments (or external partners), lots of manual work to identify the data points, and involves costs and effort for project management, coordination, and communication.

> The traditional approach requires external service providers with the appropriate expertise to make adjustments. Making adjustments after the fact is time-consuming and costly.

The ENLYZE approach

The contextualization solution offered by ENLYZE is based on automating manual tasks and enabling process engineers to perform the process withoutIT expertise, following the initial integration into the IT environment.

In this first step, the local IT experts and ENLYZE integrate our SPARK edge device into the network and connect it to the machine. From this point on, first data can be read out from the machine. Further information on SPARK and how it works can be found here.

All further steps, for the complete digitization of your machines, can now be performed location-independently from within the ENLYZE app and without IT support.

Contextualization in the ENLYZE App

After the connection with the machine has been successfully established, all relevant data points can be identified, contextualized, and permanently recorded with the ENLYZE App. This way, everyone can subsequently work with the data in a meaningful way and understand what is behind the respective data point.

The process is divided into 3 steps:

1. **Get an overview** of all data points
2. **Explore** data points
3. **Contextualize** data points

1. Overview of all data points

In the ENLYZE app, all data points of the respective data sources (PLC, sensor, etc.) are listed automatically. In addition, all relevant information that the data source provides for the data points is also displayed (such as the PLC programmer's comment, identifiers, etc.).

The listed data points can now be searched and filtered based on properties such as data type, data block, etc using simple strings. This allows the relevant data points to be found as quickly as possible.

> Added value for companies: All data points are clearly listed. The search and filter functions help to quickly identify the relevant data points - a particularly helpful feature, as the quantity of data points quickly runs into the thousands.

2. Explore data points

Data points exported directly from the data source are often cryptically labeled. **Because of this, it is difficult to find and identify the correct data points in the wealth of data points available**.

For example, the meta-information of a data point of a PLC of type S7-300 looks like this:

Datenbaustein:

DB117:2506.0

Kommentar:

Struct SP1 von Panel (Sollwert1)

(Interner) Datenpunkt Name:

Temp_regler_01_K1_03

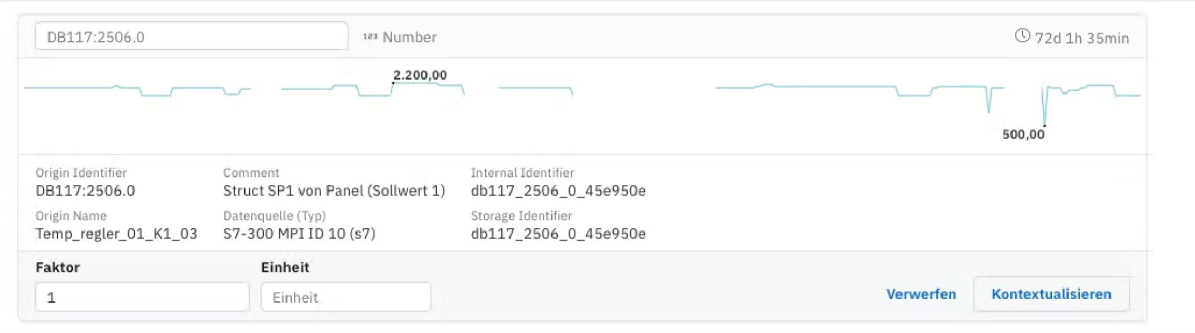
Here the available meta-information of the data point is the only information, which the S7-300 makes available initially.

Due to this limited information, **no data point can be identified clearly**.

However, the following assumption can be made: It is a temperature, possibly that of heating zone 1.

To check this assumption we've developed our unique **exploration feature**.

The data point can be explored – continuously recorded and visualized – with one click: In addition to the existing meta information of the data point, the time history of the data point can then be used to uniquely identify it and quickly prove assumptions on the actual meaning of any data point.



While a data point is explored with the ENLYZE app, ideally 2-3 photos are taken of the HMI and the process parameter values displayed on it. These images (process parameter values from the HMI) can then be compared with the history of the explored values from the ENLYZE App, via a comparison of the timestamps. This procedure enables a clear assignment of all data points.

If the exploration reveals that the explored process parameter is a data point that should not be recorded, it can simply be discarded and will not be recorded any further.

> Added value for companies: The exploration feature not only provides you with all meta information of the data point from the PLC, but also allows you to conveniently observe the data points over time. In combination with photos of the HMI, a clear assignment can thus be made quickly.

3. Contextualize data points

During the contextualization process, a human-readable name, scaling factor, and unit are set.

Defining a human-readable name:

After a data point has been identified and uniquely assigned, the data point can be given a human-readable plain name.

In our example: Temp_regler_01_K1_03 → Ist Temperatur Heizzone 1

In this way, the cryptic name of the PLC becomes a human-readable plain name. Based on the plain name, everyone understands what the data point represents.

Scaling of data points:

However, because of the way PLCs are programmed, values often need to be scaled. In our example, the value *2200* is provided by the PLC (see image below). However, our experience tells us that temperatures above 250°C cannot occur in heating zone 1.

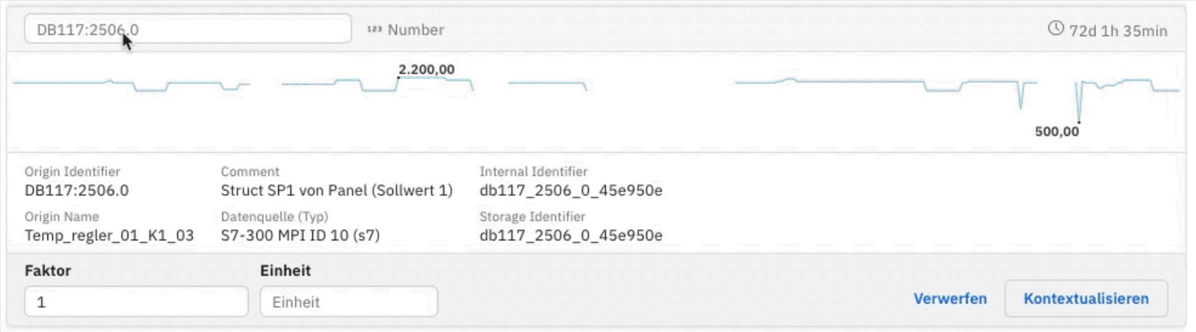
A comparison with the HMI images provides information. The temperature present at the given time was 220.00°C. Consequently, scaling with the factor 0.1 must be performed. **Scaling can be set via the scaling factor in the ENLYZE App**.

Adding a unit:

A unit must be defined for each data point. Only this defines the value of a data point unambiguously.

In our case, we are dealing with a temperature: that is why we add the unit °C.

The following shows how the contextualization of the data point is performed in the ENLYZE App:



All necessary information has now been added to the data point. A data point that was initially not uniquely identifiable has become the data point with the clear name Actual Temperature Ist Temperatur HeizzoneHeating Zone 1, which specifies values in °C°C, and needs to be scaled by a factor of 0,1. With this information, everyone in the company now understands what this data point represents and how to work with it.

By clicking the Contextualize button Kontextualisieren this information is attached to the datapoint. From now on the data point is permanently streamed into the ENLYZE platform and you and your colleagues can use it for analyzing and building dashboards.

The process of contextualization thus assigns information to any data point that in turn uniquely identifies it, **preserves** it permanently, and makes it **accessible** to everyone.

The advantage is obvious. Process experts can independently identify the correct data points and embed a representation within the platform that can be understood by anyone. Only as a result of meaningful and quick analyses can be carried out by anyone.

> Added value for companies: After contextualization, everyone can work with the data points without any problems. This enables quick handling of the data in analyses and dashboards.

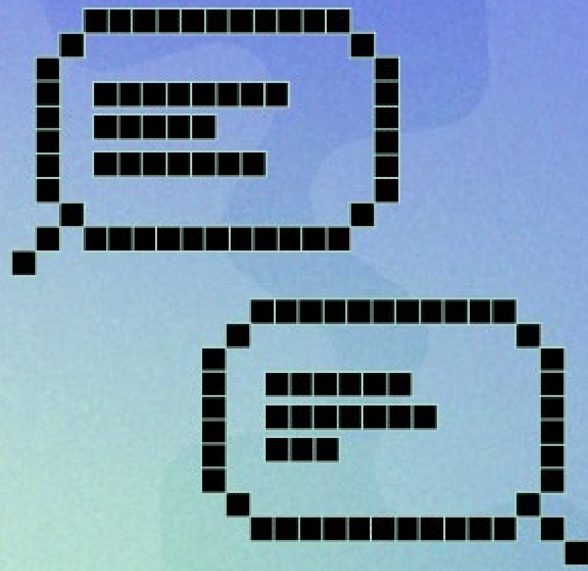
Customize and set up the system without IT capacity.

Once our system is online and after just few initial steps of IT Setup, it is easy for the users themselves to make adjustments. Adjustments to the system, such as adding or removing a data point, can be done without (external) expertise. The steps previously required by IT and external consultants have been automated within our system.

This approach benefits our customers in several ways:

- IT resources are saved: IT capacity is only needed for initial integration
- Employees can adapt the system to their needs themselves
- Unnecessary coordination tasks between IT and domain experts for data selection are avoided

> Added value for companies: Employees are empowered to adapt the system themselves. This increases motivation, reduces tied-up IT capacity and saves time and costs for project management.



Conclusion

And there you have it! A complete guide to *how to get the best production out of any machine*. We hope you feel empowered to help your team make the switch to ENLYZE for where you can derive data from existing machines and revolutionize your shopfloor.

What next? If you're ready to start exploring how everything we discussed in this eBook actually plays out, head on over to our website and **book a free consultation** to learn more about how ENLYZE can improve your productivity!

Have questions? Our team is always eager to help. Don't hesitate to reach out: hello@enlyze.com

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How to get the best production out of any machine

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