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# Get the facts on productivity & technical availability

**Viktor Kremer**
Operations Leader, GE Additive



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Users of additive machines naturally want high productivity in their process to ensure that the machine is producing at desired cost per part. High productivity does not only mean melt rate, but also yield (ability to print good parts) and technical availability. Having a machine that is operating with minimal downtime and always available to print, combined with high yield and melt rates, is the ultimate goal.

Our M Line system has been developed with these factors in mind to ensure that the user gets consistently high output.

We caught up with Viktor Kremer, Operations Leader - M Line, GE Additive, to see how the productivity of a machine is primarily governed by technical availability and discuss other factors that influence the productivity of an additive machine.

**Q: What drives technical availability?**
Technical availability is mostly driven by the design of the machine. So, the way the components are designed, the way the components are working together, the way the interfaces between different systems are designed and implemented, the interaction between hardware and software, and the motion systems all drive the technical availability of a machine. These are factors we can control, by design.

Another factor of technical availability is the way the customer uses a machine. Depending on how well the user follows the service schedules and service activities that we prescribe for a system, and how well the user follows the work instructions and procedures design can all have a bearing on the technical availability of an additive machine. We can control most factors of technical availability, but some are reliant on the user.

**Q: Which components require specific attention?**
There are several high-stress components used within an additive machine that require high durability. These carry the load of the (heavy) metal powder, so the z-axis needs to be designed to consider the different payloads used—the different materials that have different densities and weights—and the different movements that happen within the z-axis.

The M Line has been designed to carry the heaviest material, tungsten. So, all the motion systems within the M Line have been designed to be able to withstand heavy payloads.

The second area that requires specific attention in the design phase is recoating systems. You need to put a lot of thought into the guiding mechanisms, because these have traditionally been exposed to a lot of powder during printing. However, powder exposure hasn't typically been considered for the components that are used for the guide rail.

The M Line changes this dynamic. We have designed the guiding mechanism in such a way that it is placed within the machine where there is going to be as little powder contamination as possible. This helps to extend the amount of time that the machine can run without any wear effects on those rails, reducing the chance of failure occurring, which also means that you have longer service intervals than you do with other systems.

On the subject of the availability and downtime of the machine, another area that requires a lot of attention is the gas flow system. These pumps experience high rpm ranges depending on how full the filter is. So, when the filters are full, the pumps run at higher rpms, putting more stress on them. There are also restrictions to the lower-end speeds because the pumps suffer from very low rpms as well. There is an operating window where the pumps are running optimally. The M Line's systems have been designed so that all gas flow velocities fall into this optimal operating window. This means there is less stress and wear on the pumps and a lower likelihood of premature failure.

**Q: How do system complexity and technical availability affect each other?**

The higher the complexity of the system, the higher the probability of system failures. This is driven by the number of components that could fail and also how many other subsystems are impacted in case of failure. Even though the M Line is complex with many components and system interactions, it has been designed with a full system design approach, limiting those failure modes and probabilities as well as validating the system design to achieve the highest techncial availability.

To manually interrupt, correct and continue the print process to prevent scrapping the part, is not very productive overall . You don't want to waste your time and resources watching a machine and scrapping parts because of constant interruptions. In the end, the focus we put on the M Line is to have a reliable and highly available system so that you can have 'lights-off-manufacturing'. The next step we are taking is to increase melt rates to support productivity further.

The interfaces of the M Line, between the systems and the specific components, have been designed with reliability in mind. Users who are looking for production machines such as the M Line demand a higher reliability, so there's no reason for us concentrate on high productivity in the first place and not consider the reliability of the system. If you have a system with highest melt rates only but are not achieving the quality required (yield) or high reliability, then it isn't actually going to drive your business case for printing the parts.

**Q: What's the difference between yield and technical availability?**

Many people think that if you have a highly technical available product or a machine with high melt rates, then you're good to go. However, what counts is how many builds are successful and within the required specifications. There is also the possibility of you having a good-looking print, but then you take it to the lab and realize that it's full of porosity and the material parameters do not match the specifications. This then causes a lot of time, money, and material to be lost.

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machines. It's not just about having a high melt rate. This means that build-to-build and machine-to-machine variations need to be controlled at all times. This is one of the biggest contributors to high productivity. If every single print is successful, then your overall productivity is going to be awesome.

The focus of the M Line is to have a high yield rate, that is, many successful prints. Even if you have a high technical availability, many of your builds could still be failing. On the other hand, if you have a high yield and a low technical availability, you could have a 100% print success rate. But, because you can print only periodically, your overall productivity is low. This is one of the reasons that users need to look at both yield rate and technical availability—the M Line has been designed with both factors in mind.

**Q: How does technical availability affect Overall Equipment Effectiveness (OEE)?**
OEE is an equation that combines availability, performance, and quality. The customer has an impact on both the availability and quality of the OEE, while we as a machine manufacturer have an impact on all three. We've already covered the availability and the importance of having the machine available to the user as much as possible. While the performance is centered around the melt rate, the OEE of the machine is the calculation that people need to care about the most. Productivity influences OEE.. The combination of availability and quality are highly important, because it is not good for a machine to always be available if the parts don't meet the specifications, or vice versa.

The performance and melt rate do need attention, and this is something that we are actively working on. The M Line has a flexible architecture that will enable us to develop these capabilities further in the future, allowing for an increased in performance.

**Q: What can customers do to achieve good technical availability?**
Customers should continue to invest in training their teams as much as possible, and as precisely as possible. The attitude and working effort that a worker puts in is going to have an impact on the technical availability of the machine. The additive process requires a lot of attention to detail, and without proper training and focus, there is the risk of a lower technical availability or a lower yield.

Availability is a big contributor to OEE. So, if you are not treating the machine with care, you cannot expect a satisfying technical availability. The biggest factors that affect the technical ability come from us as the machine manufacturer, but the user also needs to maintain a sense of ownership and train their teams well—and sometimes opt for additional training packages to keep their knowledge up to date.

**Overall Outlook**

Anyone who is looking to scale their additive printing to production levels requires machines and systems that have a high technical availability. Without it you won't have productivity, reliability, or predictability in your supply chain. The M Line was designed to avoid the many potential failure modes that can manifest at these machine sizes through a high degree of technical availability and quality.

Technical availability is one of the many factors that can contribute to OEE, and when combined with high quality and performance, you will be able to print parts regularly and with a high success rate.

OEE is the driving factor for large-scale printing success—and it is not only governed by the melt rate—and this will become ever more important as the additive industry continues to mature in the coming years.

*If you'd like to find out more about how the different factors can be optimized in your build, or more information about how the M Line has been designed with the user in mind, get in touch.*