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# Impact of Risk Management Planning in the Manufacturing of Titanium Alloy with EOSINT M 270 Laser Machine

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## **Abstract**

*This paper provides an overview on the effects of risk management planning on EOSINT M 270 Laser machine and how to Minimize the Risk Management planning on the machine, the Importance of Risk Management Planning on the machine for future use; including the Background of EOSINT M 270 Laser Machine; and the Process of operating EOSINT M 270 Laser Machine; plus the advantages of EOSINT M270 Laser Machine.*

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**Keywords:** EOSINT M270 Laser Machine, Fabrication, Molding, Planning, Risk Management.

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## **Introduction**

### **The Background of EOSINT M 270 Laser Machine**

EOSINT, (2017), said that the additive Manufacturing offers many advantages in the production of parts, presenting unrivalled design freedom with the ability to manufacture single or multiple components from a wide range of materials. The method is considered as an additive process rather than a subtractive process that removes layers of material, such as milling. Other terms often used to describe the general process include **3D Printing, Additive Fabrication, Freeform Fabrication, Fibbing** and **Additive Layer Manufacture etc.** The early Additive Manufacturing processes were established in the mid-1980s as a solution for faster product development. At this time the practices were called Rapid Prototyping, because the idea was really to produce three dimensional models or mock-ups in order to check form, fit and function on Laser Machine. This continuing development of AM systems has enabled the fabrication of usable parts made in the desired material in a single-step process. It is now possible to manufacture almost 100% dense functional designs. Over time these systems have become more reliable and more efficient, with the range of suitable materials growing significantly (EOSINT, 2017).

### **The Introduction of EOSINT M270 Laser Machine**

The M270 Laser machine is an additive layer manufacturing system for metal components. It builds high quality metal parts from 3D CAD data fully automatically, with no need for tools. The system builds parts up layer by layer by melting fine metal powder with a laser, enabling the creation of extremely complex geometries (EOS, 2016). Parts can be made that wouldn't be possible with CNC machining, including deep grooves and three-dimensional cooling channels. The Innovative companies are using this technology for fast, flexible, cost-effective prototypes, series production parts or even spare parts. The machine is well known as leading

technology for tool making. With its high accuracy and surface quality the system is ideal for building tool inserts. The freedom of design allowed by this additive manufacturing process allows for conformal cooling channels to be integrated into parts to reduce injection molding cycling times by up to 75% (EOS, 2016). This direct process eliminates tool-path generation and multiple machining processes such as EDM. The process is mainly used for injection molding; however it can also be used for other tooling types including blow molding, extrusion, die casting, sheet metal forming, etc. The system is equipped with a solid state 200 watt laser which provides exceptionally high quality parts during the building process (EOS, 2016). The system operates in a protective nitrogen atmosphere, allowing a wide range of materials to be used ranging from light alloys via steels to super-alloys and composites. The EOSINT M 270 offers a number of powdered metal materials with corresponding parameter sets and standardized property profiles.

In addition, all materials are subjected to an intensive process development procedure and constant quality assurance. Furthermore, the machine comprises a process chamber with re-coating system, elevating system and platform heating module, an optical system with laser, a process gas management system, a process computer with process control software, and a set of standard accessories (EOSINT, 2017). The machine components are integrated into a robust machine frame. During operation the process chamber is secured by interlock. The machine comprises the process of various components, that functioning with the machine, such as:

- **Basic Data:** - This is the full details that including floor space, connections and environmental requirements (temperature and humidity range etc.)
- **Optical system:** - The optical system creates and positions the laser beam to the fuse (melt or otherwise solidify) the powder material.
- **Scanner:** - The scanner is a high speed scanner unit comprising precision galvanometer scanner with temperature compensation, actively cooled ultra- high reflection mirrors, integrated servo and interface electronics, digital data transfer from the systems control computer and digital signal processing.
- **Focusing objective:** -The focusing objective is called f- theta objective, which focuses the laser beam onto a flat field. Below the f- theta objective is a protective glass, with a pneumatic lens protection device which prevents dirt setting on the lens surface.
- **Re-coating and elevating system:** - The re-coating system creates the layers of powder. It comprises a re-coating element, a re-coated arm and a linear drive, which moves the re-coated arm in the horizontal direction.
- **Process computer with process software:** - Using the process software, the building process (job) is prepared (job) is prepared, protocol led and filed. Data can also be displayed in a graphical layer format directly on the machine with this software.
- **Process computer:** - this comprises the following materials such as processor, main memory, hard disk, monitor, and data interface, other peripheral.
- **Platform heating module:** - The platform heating module reduces temperature gradients between the building platform and the part to reduce internal stresses and ensure a good bonding of the first layers.

### **Process of EOSINT M 270 Laser Machine**

EOSINT, (2017), said that the manufacturing process of the Selective Laser Melting can be subdivided into three phases which recur periodically. During the first phase the substrate plate is lowered by one layer thickness. In the second phase a new layer is applied on the substrate plate with the help of a coater. In the last step the powder is scanned by the laser. Due to the absorbed energy the powder fused at the scanned areas. This procedure will be repeated until

the component is completed. The basic process parameters include laser related parameters and geometry/scanning related parameters. Laser related parameters include laser power, beam diameter and scanning speed. Geometry/scanning related parameters include hatch spacing, beam offset and layer thickness. Besides these, different scan patterns, such as strip, chessboard, and skin/contour settings can be selected for the part. Parameter set-up is usually tedious in the machine, but very critical to the success of the build since the micro-structure; mechanical properties, deformation, geometric accuracy and surface roughness of the part are influenced by process parameters.

Secondly, it builds high quality metal parts from 3D CAD data fully automatically, with no needs for tools. The system builds parts up layer by melting fine metal powder with a laser, enabling the creation of extremely complex geometries (EOSINT, 2016). This parts can be made that wouldn't be possible with CNC machining, including deep grooves and three dimensional cooling channels. The innovative of the companies are using this technology for fast, flexible, cost effective prototypes, series production parts or even spare parts. This manufacturing method is used for the manufacturing of tools for the plastic injection molding and the die casting (EOSINT, 2016). It is also possible to produce very filigree structures for dental and human implants. Today you can find diverse applications in the area of rapid prototyping, rapid tooling and rapid manufacturing. Currently there are ten materials qualified for this manufacturing method. These are high quality steels, titanium-, aluminium- and nickel-based alloys with powder grain sizes between 10  $\mu\text{m}$  and 60  $\mu\text{m}$ . The producible layer thickness is between 20  $\mu\text{m}$  and 50  $\mu\text{m}$  (EOSINT, 2016).

#### **Advantages of EOSINT M270 Laser Machine**

As a result of the layered build-up the selective laser melting allows the manufacturing of components with hollows and undercuts. The developer gets a huge degree of freedom concerning the part geometry without being limited by restrictions of conventional manufacturing methods. In addition to that is it possible to integrate multiple functions in the component (EOSINT, 2016). The machine has complexity of a component which has only a low effect on the unit costs, because the costs of this process are more volume than geometrical-based. Particularly suitable for the Selective Laser Melting are parts with a high degree of complexity, because its manufacturing with conventional processes is either very cost intensive or not possible (EOSINT, 2016). It offers a number of powdered metal materials with corresponding parameter sets and standardized property profiles. In addition, all materials are subjected to an intensive process development procedure and constant quality assurance. A wide variety of materials can be processed by the machine, ranging from light alloys via steel to super alloy and composites (EOSINT, 2016). EOSINT has developed novel alloys especially for the direct melting laser sintering (Direct Laser Melting Sintering) process, and it has optimized and qualified standard industrial materials such as stainless steel.

#### **Meaning of Titanium Alloy material**

EOSINT (2016) mentioned that EOS titanium is a Titanium alloy. This well known as light alloy is characterized by having excellent mechanical properties and corrosion resistance combined with low specific weight and biocompatibility. This titanium has these following properties such as: -

- Light weight with high specific strength (strength per density)
- Corrosion resistance
- Biocompatibility
- Laser sintered parts fulfil requirements for Ti6Al4V
- Very good bioadhesion

And the material has applications of used for aerospace and engineering application, and biomedical implants used in the hospital. The machine allows the highest quality parts to be produced; and the system ideal for detailed metal parts to be made layers down to 20 microns (EOS, 2016).

### **The usage in manufacturing of titanium alloy in industry**

The titanium alloy materials are used in the industry for aerospace and engineering application and biomedical implants used in the hospital and with some other products manufacture such as plastics, etc. Typically, titanium alloy in industry has applications include injection moulds and inserts for molding up to a few of parts in all standard injection parameters. The Stainless steel is widely used in many industrial applications and are typically characterized by good mechanical properties and corrosion resistance at relatively low cost. Lastly, Light alloys are widely used in industry. The most commonly used types are aluminium or titanium based. Titanium based alloys are commonly used in applications with demanding requirements, but parts are typically expensive to manufacture conventionally, because titanium is generally difficult to cast and to machine.

The risk management is the effects that occur when the right attitude and methods are not put into practice when working with the equipment, machines and tools in the workshop. This effect damages some of the equipment must times because of careless handling of the equipment after daily used in the workshop. According to Michael (2016), option that the risk management planning is a process of identifying analysing and responding to risk factors throughout the life of a project in order to provides a rational basis for decision making in regard to all risk. . A proper risk management plan implies the control of possible future events, which is proactive rather than reactive; and also it is embedded into the project planning process; but it will reduces not only the likelihood of an event occurring, but also the magnitude of its impact. He said the intention of the risk management planning is to reduce management from crisis and accident on the machines and equipment. However, the risk management plan contains an analysis of likely risks with both high and low impact, as well as mitigation strategies to help the project avoid being derailed should common problems arise. Risk management plans should be periodically reviewed by the project team to avoid having the analysis become stale and not reflective of actual potential project risks (John, 2016).

There are many approaches to risk management planning, but essentially the risk management plan identifies the risks that can be defined at any stage of the project life cycle. The risk management plan evaluates identified risks and outlines mitigation actions. A risk management plan should be periodically updated and expanded throughout the life cycle of the project, as the project increases in complexity and risks become more defined. Risk management ideally takes a project throughout the phases of risk identification, risk assessment and risk resolution (Michael, 2016). With the advancement in project management studies and techniques, risk management has taken a main place in the project cycle life, the most cases at the outset of the project itself. Risk management plan is an ongoing process that continues through the life of a project. It includes processes for risk management planning, identification, analysis, monitoring and control of the machine. Many of these processes are updated throughout the project life cycle as new risks can be identified at any time. It's the objective of risk management is to decrease the probability and impact of events adverse to the project when working on machine in the workshop (John, 2016).

### **Effects of Risk Management Planning**

Ashton & Ashton (2016), said that the effects of the management planning process are a quality problem, solving process; it has a quality and assessment tools to determine and prioritize risk for assessment. The effect of risk management planning needs to be an ongoing effort that cannot stop after a qualitative risk assessment, or the setting of contingency levels; the effects of risk management was to minimize the impact of the risk events on equipment, and machine uses in the workshop, and occurrence on the project or practicals; and also to help the system of operating the machine, and accident that may likely occur when working on the machine. If only the effect can be obey and put into practice with the rules and regulations of the machine when operating the equipment and machines in the workshop.

### **Minimize the Risk Management Planning**

Amado (2016), mentioned that when planning project, risks is still uncertain they happened yet. But eventually, some of the risks that you plan for do happen, and that's when you have to deal with them. There are four ways to handle or minimize the risk management planning such as: -

- **Avoid:** The best thing you can do with a risk is to avoid it. If you can prevent it from happening, it definitely won't hurt your project. The easiest way to avoid this risk this is to walk away from the cliff; but that may not be an option on this project.
- **Mitigate:** if you can't avoid the risk, you can mitigate it. This means taking some sort of action that will cause it to do as little damage to your project as possible.
- **Transfer:** One effective way to deal with a risk is to pay someone else to accept it for you. The most common way to do this is to buy insurance.
- **Accept:** when you can't avoid, mitigate, or transfer a risk, then you have to accept it. But even when you accept a risk at last you've looked at the alternatives and you know what will happen if it occurs. If you can't avoid the risk, and there's nothing you can do to reduce its impact, then accepting it is your only choice.

By the time a risk actually occurs on your machine, it's too late to do anything about it. That's why you need to plan for risks from the beginning and keep coming back to do more planning throughout the use of the machine (Michael, 2016). The effect of risk management plan tells you how you're going to handle risk in your workshop. It documents how you'll assess risk, which is responsible for doing it, and how often you'll do risk planning since you'll have to meet about risk planning with your team throughout the project. Some risks are technical, like a component that might turn out to be difficult to use. Others are external, like changes in the market or even problems with the weather (Gary, 2016). It's important to come up with guidelines that help you to figure out how big a risks potential impact could be; this will tells you how the damage the risk would cause to your machine in the workshop. Many projects classify impact on a scale from minimal to severe, or from very low to very high. To minimize the risk management plan that gives you a chance to figure out the probability of the risk. Some risk is very likely; others aren't likely.

### **The Importance of Risk Management Planning**

Michael (2016), said that one of the importance's of risk management planning in the workshop is the projects often started in the right direction but then get off track. For example, project managers who spend time with their teams to develop a clear scope and detailed plan. Then something happens; something unexpected on machine, a major disaster strikes when risks are not put in place. The project manager and team move quickly into their reactive modes, they manage this risk on the basis of their experiences and best judgement but they have no

opportunity to test it out and they hope that it'll be okay, but they do not know for sure. This is not risk management; it is management by crisis with the machine. Here are ten rules to help you manage the project risk effectively on the machine: - Here are ten (10) rules to help you manage project risk effectively.

**1. Identify the risks early on the machine or project:**

- Review the lists of possible risk sources as well as the project team's experiences and knowledge.
- Brainstorm all potential risks.
- Brainstorm all missed opportunities if project is not completed.
- Make clear who is responsible for what risk.

**2. Communicates about the risk effectiveness:** - The following points are the reasons why we need to communicate the risk effectiveness during the using of the machine such as: -

- Pay attention to risk communication and solicit input at team meetings to ensure that your team perceives that risk management is important for the project.
- Focus your communication efforts with the project sponsor or principal on the big risks and make sure you don't surprise the boss or the customer.
- Make sure that the sponsor makes decisions on the top risks, because some of them usually exceed the mandate of the project manager.

**3. Consider the opportunities as well as threats when assessing risks:** - While risks often have a negative connotation of being harmful to projects, there are also "opportunities" or positive risks that may be highly beneficial to your project and organization. Make sure you create time to deal with the opportunities in your project. Chances are that your team will identify a couple of opportunities with a high pay-off that may not require a big investment in time or resources. These will make your project faster, better and more profitable.

**4. Prioritize the risks:** - The prioritize risk has a necessary ways of manage the risks such as: -

- Some risks have a higher impact and probability than others. Therefore, spend time on the risks that cause the biggest losses and gains. To do so, create or use an evaluation instrument to categorize and prioritize risks.
- The number of risks you identify usually exceeds the time capacity of the project team to analyse and develop contingencies. Therefore, the process of prioritization helps the project team to manage those risks that have both a high impact and a high probability of occurrence.

**5. Fully understand the reason and impact of the risks:** -

- Traditional problem solving often moves from problem identification to problem solution. However, before trying to determine how best to manage risks, the project team must identify the root causes of the identified risks.
- Risk occurs at different levels. If you want to understand a risk at an individual level, think about the effect that it has and the causes that can make it happen.

**6. Develop responses to the risks:** -

- Completing a risk response plan adds value to your project because you prevent a threat occurring or minimize the negative effects.

**7. Develop the preventative measure tasks for each risk:** -

- It's time to think about how to prevent a risk from occurring or reducing the likelihood for it to occur. To do this, convert into tasks, those ideas that you had identified that would help to reduce or eliminate risk likelihood.

**8. Develop the contingency plan for each risk: -**

- Should a risk occur, it's important to have a contingency plan ready. Therefore, should the risk occur, you can quickly put these plans into action, thereby reducing the need to manage the risk by crisis.

**9. Record and register project risks: -**

- Maintaining a risk log enables you to view progress and make sure that you won't forget a risk or two. It's also a communication tool to inform both your team members, as well as stakeholders, about what is going on.
- If you record project risks and the effective responses you have implemented, you will be creating a track record that no one can deny, even if a risk happens that derails the project.

**10. Track risks and their associated tasks: -**

- Tracking tasks is a day-to-day job for each project manager. Integrating risk tasks into that daily routine is the easiest solution. You may carry out risk tasks to identify or analyse risks or to generate, select and implement responses. The daily effort of integrating risk tasks keeps your project focused on the current situation of risks and helps you stay on top of their relative importance.

It's necessary to obey the important of risk management plan in our various place of workshop, and not only with the workshop but when operating the machines, and when using the equipment in the workshop. The importance of risk management planning takes significant guides in preventing the life span of a machine and also helps you in achieving best product when producing with the machine. The safety habits on the machine when using it elsewhere could be achieved with the assistant of risk management planning.

**Recommendation**

The following recommendation were observed by Marks, (2016) during the operating system of EOSINT M 270 Laser machine which needs to improve upon are as follow: -

- The surface quality of the product produce on the machine is always not too good in appearance and at the time the surface look rough. So to achieved a surface quality on the product produce you need to enhanced the method of employing a variety of surface modification to the technologies, such as mechanical and examples of that is abrasive sandblasting and chemical e.g. acid etching. From my own observation that it's how the product always look like when it build up on the laser machine, but the best solution is to polished it before using the product.
- The powder materials used in the laser machine cannot be re-used after using it on several occasion, they will need to change it previously. Haven't looking at the platform of laser machine it has a small sizes in shapes and the powder too is always put in the platform box; the operating system of layers moved across the platform both left and right and powder spread at the surface of the block table to build the object.
- Selective Laser Melting platform is too small and it cannot be used for a large product because of the designing of the machine. Direct base of the platform 250x250mm in size to fill the build area, and also attached to the carrier screw. The reasons why is like that is that the focus point of layer is always be at each point of the platform, and cross the centre point to build upon, so to determine the centre point of the platform where the object will be layer. Finally, if the platform is bigger than that the machine will lose focus on the product produces on the machine.
- The effects of the laser process parameters on the machine need to be correct before operation start on the machine.

- The effects of laser power, scan speed, etc. needs to be considered with the supply of lighting that it's the lighting needs to stay able all the time during the operation of the machine (Mark, 2016).

### **Conclusion**

In conclusion, the machine has a good excellent mechanical properties, high resolution and exceptional quality surface. It has very good advantages of the product produce on it to the market. More also, part of my conclusion on EOS laser machine is that the method allows you to create products with extremely complex geometries including elements such as free form surfaces, deep slots and coolant ducts. Secondly, the machine offers many advantages with the top quality, accurate, clean prototypes that can be built in hours and shipped to the customer in a few days. The services are priced very competitively in the industry while providing the best in quality and customer service. Lastly, it equally processes the following quality such as innovation, quality, flexibility, and user friendliness that can achieved in all components.

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