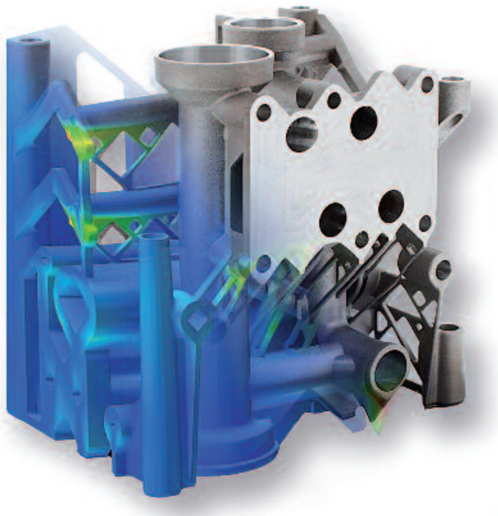
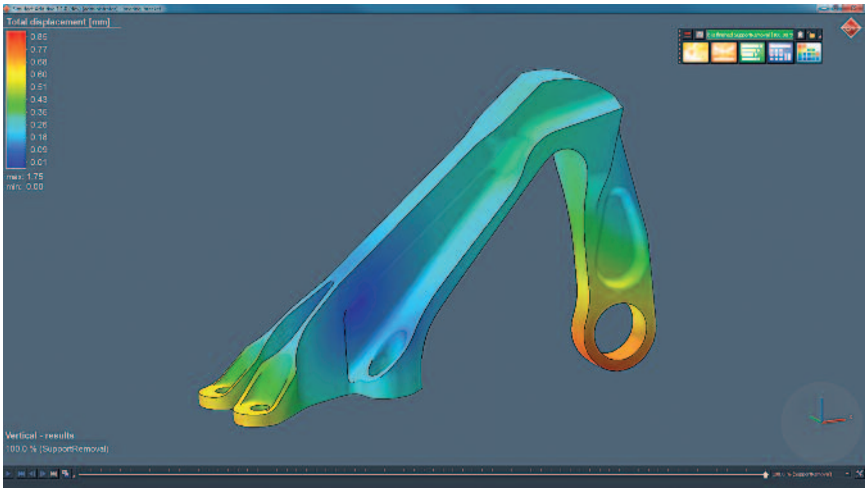


“Without SIMULATION, no way”

Simufact is one of the pioneers in the exciting field of simulation for metallic additive manufacturing. Hendrik Schafstall, General Manager & CTO with the vendor, explains state-of-the-art applications.

Dr. Schafstall, what makes your company deal with additive metal manufacturing?
We at Simufact have set ourselves the general goal of numerically reproducing production processes. And this includes additive manufacturing. Our first product in this regard focuses on the widespread powder bed melting, which is only possible in a limited space – the machines have a typical construction area of a maximum of 800 x 400 mm. This is reflected in the simulation, because such

Hendrik Schafstall stands up for CAE software that brings benefits to users with manufacturing background



Simufact Additive calculates the complete process of powder bed melting

volumes are easy to handle numerically. Here, we focus on the modeling of manufacturing parameters that affect the final part.

What do you understand by 'modeling manufacturing parameters'?
An important result of the simulation are precise statements about the final shape of the components. This manufacturing process is carried out at very high temperatures, leading to residual stresses and as a result of that to deformations. We make these effects visible with our software.
Furthermore, we also investigate follow-up operations: After layering, the part is separated from the building board of the printer and the support structures are removed. Separation can cause internal stresses too. Following this, the component can be heattreated to relieve stress and achieve a uniform texture.
Owing to the welding process in the powder bed, the component material can become porous and therefore susceptible to cracking. This is very dangerous in aerospace applications, which therefore usually entail a hot isostatic pressing (HIP) process. In this so-called HIP process, the material is heated from the outside under pressure in order to close any pores. Our Simufact Additive software also takes this processing step into account in order to deduce what the final component actually looks like.
In addition: Printing is known to lead to rough surfaces that need to be smoothed or polished by subsequent machining. We believe that these add-on steps must also be included in the analysis in order to take into account as far as possible all the effects that cause costs and to be able to optimize the manufacturing process in its entirety.

What ideal user do you have in mind with Simufact Additives?
We have created a solution that maps the entire scope of the process steps mentioned before. The software is primarily aimed not at the calculation engineer, but at the user with a manufacturing background. He brings the necessary understanding of the relevant degrees of freedom in production and can achieve meaningful optimization of the process by playing through possible variants.
Simufact Additive is really new, we launched it in November 2016. In the first step, we concentrated on ensuring a very high quality of results – calculated geometries, warping, residual stresses that are very close to reality for all possible structures, some of which are extremely detailed.

Which are the next steps the user can expect?
We are in the process of implementing optimization algorithms to provide the user with suggestions based on what-if loops with automated variational calculations – e.g. optimal in terms of the geometry accuracy, but also in terms of cost issues. We will bring this consistent next step to market with our upcoming release in the middle of this year.

Do you also target laser deposition welding?
When we talk about laser deposition welding, we are talking about very large structures, e.g. in aerospace that can be much larger than 10 m, posing great challenges for modeling.

Gosh! How do you deal with that?
As part of publicly funded projects, we work together with other industry partners on suitable technologies. We have positioned our efforts in the working group 'Welding' because this process can be understood as multilayer welding. It requires comprehensive modeling that we want to support with automation algorithms. The goal is to directly incorporate the already known parameters

of production planning and thus to minimize the processing times.

Can your investigations also be used for other scenarios?
Basically yes. After all, in general, the question arises as to where we as simulation tool providers can offer added value. Here we investigate the market in all directions.

What are the most noteworthy challenges of modeling techniques?
First of all, the models are huge in terms of dimensions. An enormous number of layers must be mapped efficiently in order to recognize a trend within a short timeframe, enabling intervention with targeted optimization. At the moment, we need computing times in the range of months or even years, which is completely unacceptable. Hence, first-of-a-kind concepts of simplification are required that provide satisfactory results without too much loss of accuracy. We are currently working on that. However, any new idea for an algorithm needs to be carefully validated, particularly when it comes to aerospace applications that require very reliable statements.

Speaking of application in general: Are there differences with regard to the automotive and the aerospace sector?
We are currently exploring what options exist from a manufacturing point of view to draw conclusions about what a functionally highly integrated design should look like.
Strictly speaking, 3D printing is an old manufacturing method. It has been on the market for 25 years, initially primarily for rapid prototyping. Later it became clear that lightweight structures can also be produced efficiently in this way. They are more expensive to manufacture, but you save weight. And in aviation and aerospace every kilogram saved really brings money! Therefore, this industry has pushed this technology forward to save as much weight as possible on parts where safety-relevant criteria play just a minor role.
In the next step, the aerospace industry has created complex, functionally integrated drive components with additive manufacturing processes, such as optimizing cooling ducts, injectors, and other innovations. Even in these applications, high production costs are secondary, the weight saving is of enormous advantage.
The automotive industry has become aware of these achievements. There, activities are currently still concentrated on prototype generation. At the same time, however, new fields of application are also being researched here: Certain tools, moulds and jigs for production are produced additively. Here, for example, near-surface cooling channels can be realized in injection moulding tools, which allow shorter cycle times and a higher number of cycles in mass production. It also examines the extent to which it makes sense to print smaller complex components, such as ancillaries.
Another interesting field is the supply of spare parts. For example, special spare parts for the all-wheeldrive medium truckmaker Unimog can be simply printed on demand, so that you save their storage.
Large-scale production in the automotive industry is currently not in focus for the additive production of metal components, however, the situation is different for small series: For high-end sports cars, such as the Volkswagen Brands Bugatti, Audi R8 (including the A8), they are investigating applications of the technology that make sense – even if it is known that the parts produced in this way are more expensive.

How do you rate the entry of major players such as GE or BASF into the 3D printing realm?
Even the production of a metal powder is extremely expensive. It must be ensured that the grain sizes are as homogeneous as possible; that is very expensive. At present, new alloys are under development, which have special properties for additive manufacturing. The automotive industry is waiting for these results. So far, mainly Ti alloys, Inconel (Ni-base alloys), Al alloys and a restricted amount of steel alloys are available. But there's a lot going on in the exciting field of materials research.

But that also means that Simufact is challenged in providing modeling techniques…
…without doubt! Not all physical dependences are adequately described mathematically for the latest materials. So, we need to remain on the ball and investigate how these materials can be characterized, for example with regard to the modeling of the powder grains level or at the component one. We are not only looking for the proximity to the material manufacturers, but also to the user companies…

…in other words, it can't be done without simulation…
…definitely not with the new materials, because there is hardly any experience with them. Moreover, machine control is a very short-lived business. The basic knowledge must be laboriously worked out, with neither time nor money in abundance. That's why the simulation is so extremely important.

Thank you for the interview!

Questions: BERNHARD D. VALNION