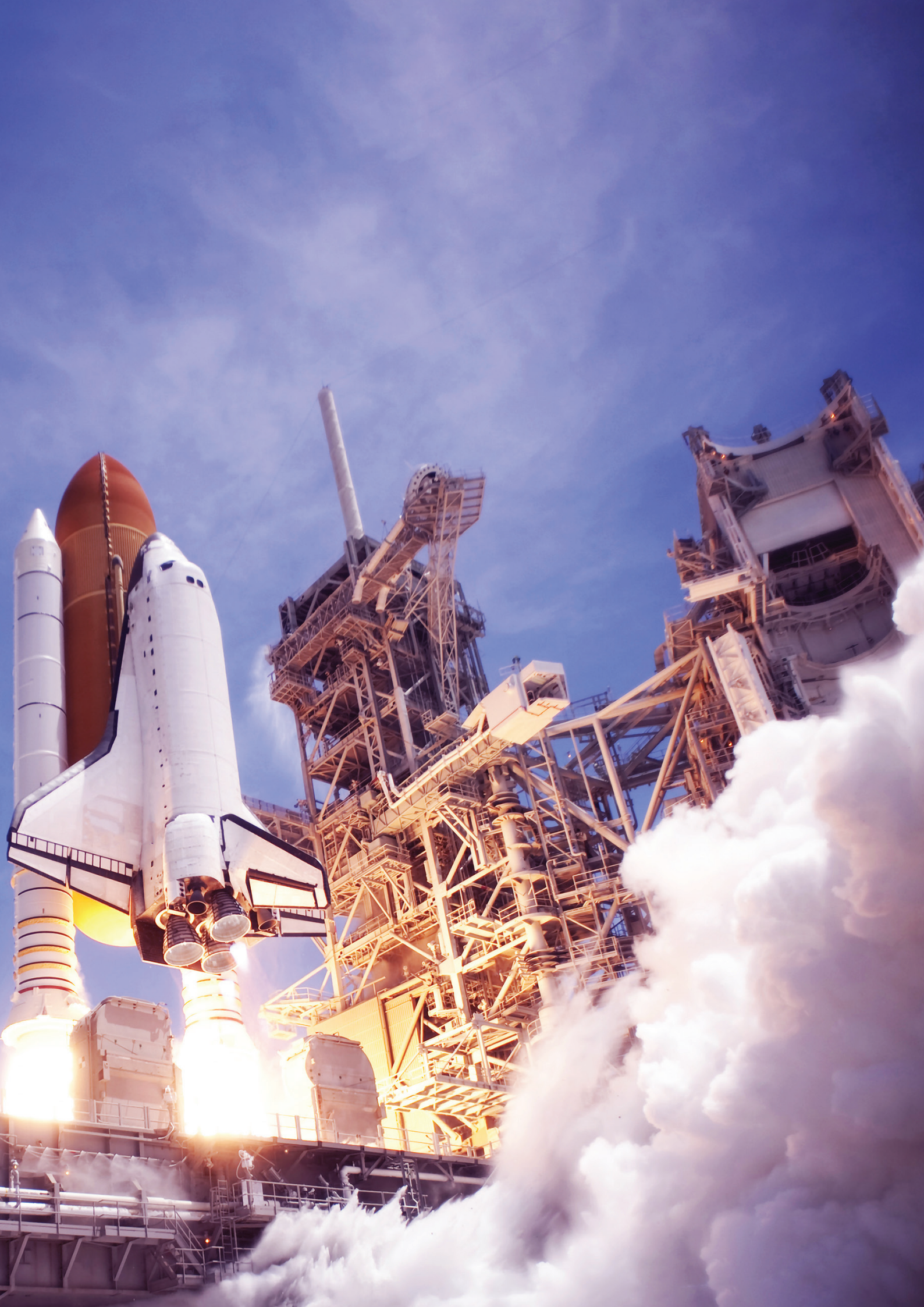
An Interview on -

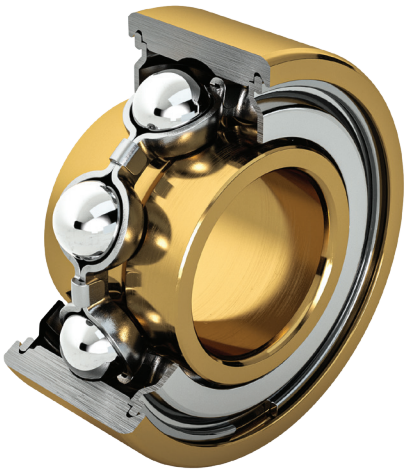
Launch Loads in Space Applications

GRW has been developing and researching for many years the use of bearings in space applications. The company has achieved a tremendous experience and lessons during these years and is producing different bearings and components thanks to their highly skilled and well-equipped R&D department. In this interview we had the chance to discuss the analysis and recommendations for design optimization with Dr.-Ing. Rahul Dahiwal, the R&D Project Manager at Gebr. Reinfurt GRW. His answers to the questions can be considered as a general guideline and recommendation which can help the space community to avoid early design errors, to optimize their solution and assist in selection of the correct bearing for the space applications.



Q: Can you tell us more about your history at GRW, your background and current activities?

I am a mechanical engineer by profession graduating from Pune University, India with a bachelor's. To pursue further studies I came to Germany where I completed my master's and acquired a Ph.D. from the Technical University of Kaiserslautern. As a Scientific Researcher at the university from 2014 to 2020, I was in the bearing research group and worked on several research and development projects during my research activities. I did my Ph.D. in cage wear influence on bearing life in solid lubricated rolling bearings. All these qualifications and expertise helped me to get started with Gebr. Reinfurt GmbH & Co. KG. I have been employed with GRW since January 2021 and work as a specialist of ball bearing in the product development department / R&D. I am responsible for managing development projects, where I support relevant departments in the early development stage. As a technical contact person to suppliers as well as to our customers, I provide support for their queries and am actively involved in performing simulations and experiments.



Q: On which project are you currently working on?

Currently, I am handling multiple Technical Projects with a prime focus on designing bearing solutions in space applications. The applications include On-Board subsystems for communication satellites like reaction wheels, LIDAR sensors, Gyros or Gimbal mechanisms, and actuation systems, for example, on solar panels. Besides these, I am working on some internal development projects like finding sustainable dry lubrication solutions (coatings) for bearings that can withstand harsh environmental conditions. I also apply Lean Project Management techniques to enhance our departmental capabilities through digitalization. Here, I intend to deploy advanced computational tools for the static (FE) and dynamic (Multi-Body) simulation and analysis of rolling bearings. This will help to provide our customers with the quick and best solution in their early development phase and help them to find the right bearing selection.

Q: You quoted on an earlier discussion that "the systematic analysis of the effects of launch loads is a key part of the process to select the best bearing solution for a given application".

Can you brief us more in-depth about what you exactly mean?

If you have a systematic approach, irrespective of the complexity of the problem you can come to an accurate solution more quickly. After all, a bearing itself looks like a very simple component, although internally it is actually a complex system that involves decades of engineering

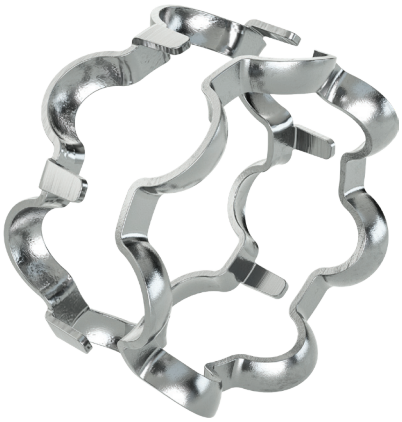
— **Dr.-Ing. Rahul Dahiwal,**
the R&D Project Manager at Gebr. Reinfurt GRW

research covering many branches from metallurgy to materials and tribology. To solve such a complex system you have to marry well the experimental work together with the theoretical or simulation work. Launch loads in space applications illustrates this perfectly as they are usually underestimated or overlooked during the selection of bearings. Under such momentarily acting high static loads, if a bearing fails to cope, it results in serious consequences such as an entire system failure followed by a mechanical failure. To avoid such things one should systematically perform static calculations, simulations with advanced bearing simulation tools, and conduct experiments for verifying the results with the experimental data taken into account the real operating conditions. In this way, we can beat this challenge.

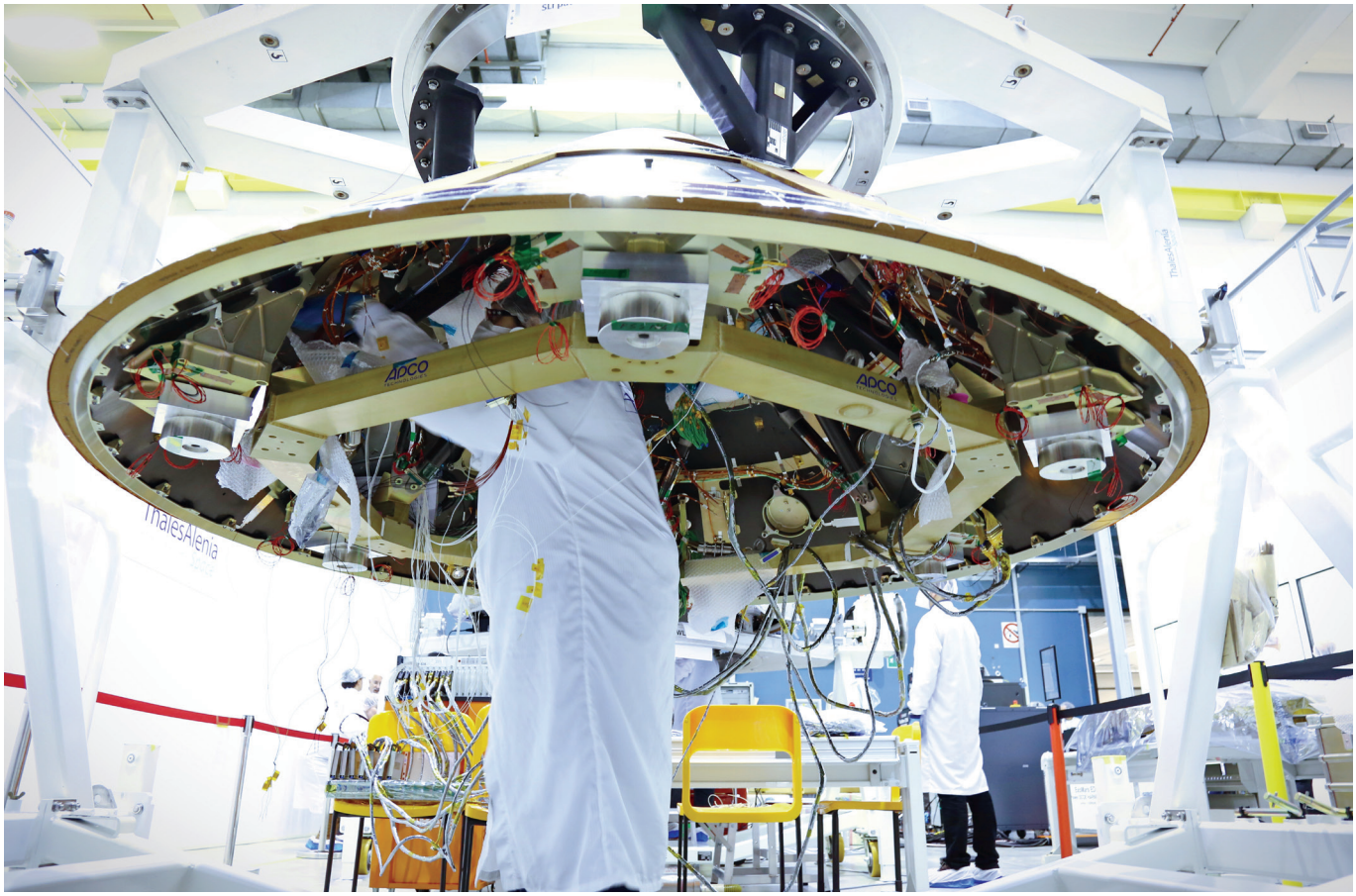
Q: Are the simulators and software which are currently used in the industry sufficient for an accurate analysis and design optimization?

Is there still room and need for improvement? Implementation of AI?

Well, I would say that we have good support in the industry for an accurate analysis and design optimization, but at the same time, there is room for improvisation. Whilst there are certain bearing analysis programs available at large companies or a few research institutes, they are not commercially available. Most of them are intended for internal use or are available within the research community because the organization that developed it has already put a lot of research, money, and time into developing such software. It does not



want to make them freely available. That is why, on behalf of small to medium scale enterprises, there is potential for further development of such analysis tools, their access, and commercialization strategy. If we talk about AI, though it is a sort of



— Turin, Italy - October 2015: Technicians working on the ExoMars probe module, for a European mission to Mars, at the Thales Alenia Space plants (Shutterstock)

intelligence in the end it is artificial. AI works on data analysis and complex user-developed algorithms. Their intelligence is based on the size and accuracy of the data available. To generate accurate and huge data, you again have to seek help from simulations and experiments. But, I find it personally very interesting and challenging as well, as we see the ongoing research in this direction for the prediction of bearing failures. As bearing experts we must track the progress and if necessary take the corrective actions in the right direction.

Q: Which are the important phases of the Methods and Techniques for Bearing Design and Selection

A critical part of bearing design and selection is to become familiar with the exact operating conditions. These are nothing but loads, speeds, and environment (temperatures etc) they are operating under. Based on this information we can select a suitable bearing size. The second most important thing is the right material selection for bearing components like rings, cage, and rolling elements, which is important for the bearing load capacity of the bearing. Also critical is the lubrication selection that suits the environment and fulfills the operating conditions. As a super precision ball bearing manufacturer, GRW's portfolio contains a wide range of material and lubrication selections. Besides conventional lubrication, we possess the expertise to offer around thirty coating solutions intended to lubricate the bearing under harsh environmental conditions and protect the bearing surfaces against wear, fatigue, and corrosion. Once the bearing is selected, it must pass through bearing qualification techniques by performing fundamental simulations and tests like noise testing, friction torque testing, and use an adequate quantity of lubrication. At every level GRW makes sure that we make the right choice for the customer application.

Q: How do you see the human and industrial activities in space increasing in the future?

There are many advancements going on in the space domain. Space applications are being widely used for earth exploration, navigation, and communication. For instance, satellites play an important role here. Autonomous driving is the classical example for communication satellites.

Recently NASA has also commercialized SpaceX activities and appointed them to send their astronauts into space. Human space travel is looking more certain and will happen in the next couple of years for sure. Nevertheless, whatever goes into space has some rotating mechanisms, and whatever rotates needs bearings for its support. As I have already mentioned in my published article the prediction is that around 1400 small satellites per year will be launched over the next ten years. Therefore, it is clear how much business potential there is in this industry.