



Featured topic
Industry 4.0



Theory of Constraints
Making the market the bottleneck

No. 15 – 2017



Just in time
*High performance materials
off the printer*

LIVING METALS

Read the story behind the cover on page 32.



Strong metals for a high-tech world

The best way to get rid of your tungsten scrap fairly and quickly.
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Dear Readers,

Welcome to our new issue of livingmetals!

livingmetals is now the corporate magazine of the Plansee Group for customers, business partners, employees and anyone interested in our company – be they applicants, suppliers or prospective customers. livingmetals is available both in traditional form as a printed magazine, and online at www.plansee-group.com.

Are you into marathons?

No? We at Plansee Group have been training for our marathon – our internal long-term fitness program – for two years now. And this training is paying off. Our goal of becoming the best-performing supplier and partner to our customers in the market is within grasp. How can you tell? Fast quotes, reliable delivery periods, and competitive products in every respect. Have we reached our goal? Far from it! But we are working on it.

Time to get more fit!

To optimize means to be competitive!

TOC is our magic formula that will help us boost throughput and make our companies become more efficient – one day at a time. TOC – the Theory of Constraints – is about increasing throughput of the entire company by deliberately eliminating bottlenecks. Bottlenecks include long set-up times, the production of 'scrap', unstable processes, and insufficient equipment uptime. Entire teams are directing their full attention to removing these issues. What is great about TOC is that, once a bottleneck has been eliminated, a new one emerges. So you are never done. With every bottleneck we overcome, the entire organization becomes more efficient.

Getting stronger!

To invest means to grow our position in the market!

Plansee has again invested heavily in recent years: in the development of new products and technologies, and in the expansion or upgrade of manufacturing capacities. This allowed us to significantly increase production volumes – even though this is not reflected in the sales figures because of the low prices for raw materials.

Getting smarter!

To digitize means to secure our future!

We are convinced that digitization will bring with it tremendous opportunities – in three areas.

- Even now, we not only produce wires, ribbons, sheets and rods, but a wealth of data. When sensibly evaluated, this data will be a virtual treasure trove to systematically and sustainably improve processes and flows, reduce the use of resources and energy, and provide even better service to our customers.
- Downloadable inspection sheets; clear, easily traced product identification; remote diagnosis, and automated order and delivery processes. We are working on opening our systems to our customers at all points of contact – offering them added value in their day-to-day work.
- Ultimately, we want to and must simplify our order processes for the customer. A major focal area is therefore to completely revamp our e-commerce activities and online shops. Let us surprise you.

We hope you enjoy browsing and reading this issue.

Bernhard Schretter and Karlheinz Wex

Executive Board Plansee Group

Strong metals for a high-tech world

Without them, our modern world is inconceivable: Hard metal tools and the high-performance materials molybdenum and tungsten make our lives reliable, convenient and safe.

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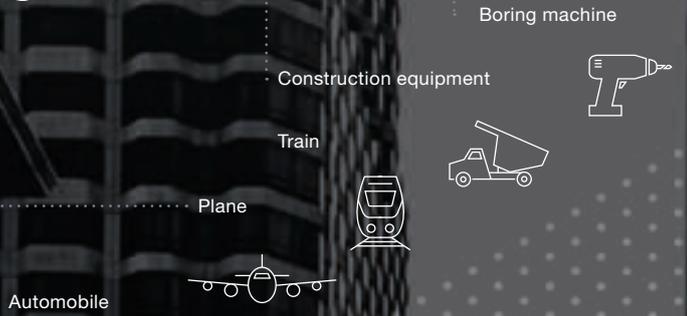
Automotive industry

for our mobility

Aerospace industry

for our energy

Energy technology



Turbine



Solar cell



Wind turbine



Oil and gas production



Power transmission



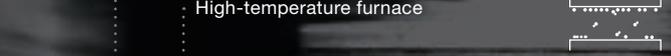
Fuel cell



Semiconductor production



Machine tool



High-temperature furnace



Coating machine

molybdenum

Mo

W

for our daily lives

LED



Cinema lamp



Display



Smartphone



Ballpoint pen



Camera



Body scanner



Food packaging



Computer tomograph



Dental drill



Print and paper



Stone machining and woodworking



Tool & Die



Metal forming technology



Glass making



Injection molding

Consumer electronics

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Mechanical engineering

Medical technology

for our industry

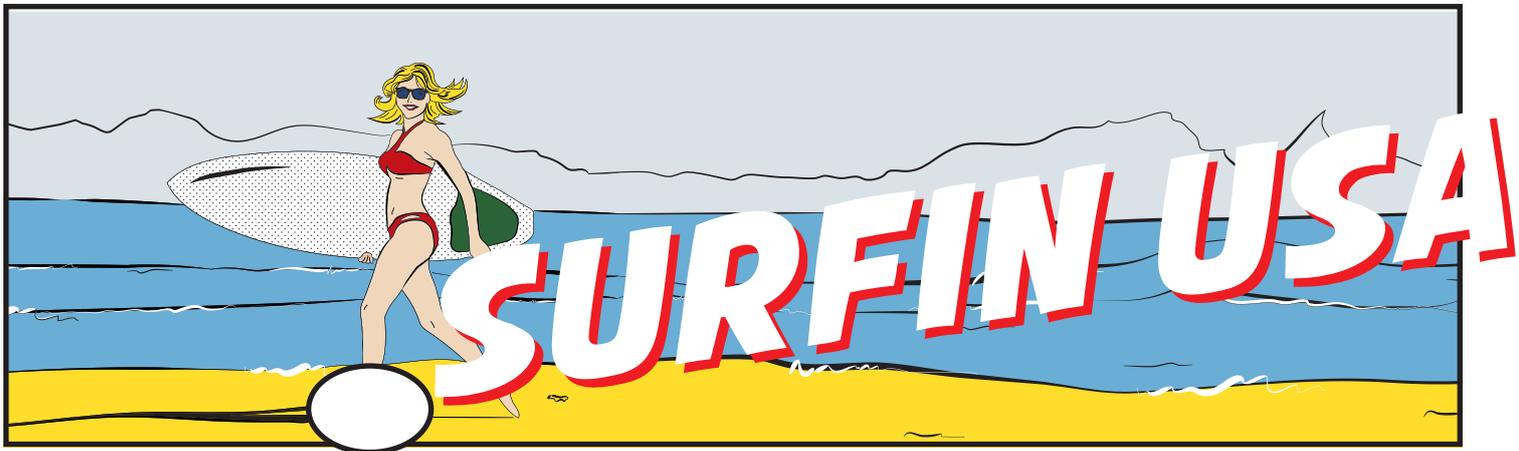
Construction industry

tungsten



tungsten carbide





In the fall of 2016, six Plansee employees relocated to California for four months to expedite development of suggestions for new business models for the digital world.

This is an update from Plansee's futurology shop.



A long look (no surfing just yet) through the customer's glasses

Well over 50 employees had applied for this project at Plansee. Everyone wanted to work on the exciting issue of how a materials manufacturer steeped in tradition with decades of success should evolve to maintain and grow its market position in tomorrow's digital world and beyond. The selected participants were a diverse team: European patent attorney Dr. Elisabeth Eidenberger-Schober, marketing specialist Nadine Kerber, simulation expert Dr. Arno Plankensteiner, process engineer Balaji Ravi, **Pain Points** key account manager Vlad Ocher, and sales engineer Tony Feng. All six employees left their previous jobs behind and dedicated their time solely to the project. The countless brainstorming sessions, interviews and workshops as well as extensive research produced far in excess 100 ideas, 45 concept sketches, **Substantial amount of time spent** and 25 rough concept drafts.

Between Los Angeles and the beach

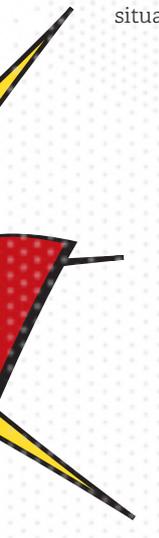
BCG Digital Ventures, headquartered southwest of Los Angeles, just a few hundred yards from the beach, assisted Plansee with the collection, assessment and development of concepts. The six Plansee employees had a pool of dozens of advisors, coaches, researchers and other specialists at their side. Open-plan offices, smaller rooms for workshops, and central lounges for communication and refreshments provided the ideal setting for all **Time and energy is spent gathering required information from disparate sources** situations. Team composition changed almost daily as needed.

The concepts they developed spanned a vast range: from the use of the essential trace element **Searching for new suppliers is time consuming** molybdenum in a lifestyle-brand health drink, to a platform for brokering unused production capacity, to Plansee offering insurance to provide coverage if competitors are unable to fulfill a production order. To sum it up: a whole host of great concepts that will keep Plansee and its customers occupied for many years to come.

The assessment of ideas by the Plansee team always centered around the customer. What does a metal working business like Plansee have to do to best support its customers' business models? The goal was to understand the environment that results in a buying decision – along the entire **to find the right person in organization** value-added chain. Admittedly, this is a very vague term, which requires definition for every business case. For Plansee, this means, for example, that we support the customer from the quest for a suitable materials solution to the actual purchase of a product. We ask: What are customers looking for – and where? Where do they get support, and where do they still need it? What frustrates them? What areas have they long given up on because, in their view, there is nothing better out there? But we also ask: What do they like? Where do they feel they are being well-supported? Do they have their own ideas on how things could be done better?

»
We want to develop the future of the Plansee Group together with our employees.
«

Dr. Arno Plankensteiner
Simulation expert



———— To explore these questions, the Plansee team conducted countless interviews with representatives from a wide range of sectors – from toymakers to aerospace companies – and many different positions: designers, buyers, consultants, and chief development officers. Interview partners **Complex process even for small purchases** These functional sketches were then tested on select users to determine whether these in fact satisfy their needs. This results in effective approaches for the continued development of the concept. Ultimately, there were three very **Low trust and confidence in new suppliers** concrete ideas or projects. Of these, the Executive Board and Management slated one project for further implementation.

Lack of consolidated information were asked how they decide on **on potential suppliers** required material properties and what avenues they pursue to find molybdenum and tungsten, or other suitable materials. **Poor communication on supplier side**



———— After an initial review and appraisal of the collected ideas, the focus shifted toward turning a few promising ideas into **product visions**. These are graphical functional sketches that are tailored to future users and cater to their presumed needs. These functional sketches were then tested on select users to determine whether these in fact satisfy their needs. This results in effective approaches for the continued development of the concept. Ultimately, there were three very **Low trust and confidence in new suppliers** concrete ideas or projects. Of these, the Executive Board and Management slated one project for further implementation.





No systematic process
to quickly filter and compare suppliers



Overwhelming number of available materials
leads to difficulty choosing the right material



1c- 2c
Commodity

The first phase of the project is complete, and you're back in Reutte. What insights did you take away?

The contact with other people and new topics has made us more multifaceted and independent. We realized how our talents and past experience contribute to our professional effectiveness. We would have never discovered those without this project.

————— Nadine Kerber



5c-25c
Good

The first step is never about finding the perfect solution. What matters is a lot of empathy for the customers' needs and expectations. Many developers are still researching material specifications in age-old, last-century tomes – either because they can't find anything better online or because the databases there are incredibly expensive, but not very efficient. And this in the digital age!

————— Elisabeth Eidenberger-Schober



75c-\$1.50
Service

It became evident in a number of interviews with (potential) customers that service standards in the consumer field are also being expected now in a business-to-business setting. For Plansee this means that we want to, and must, create a great experience for our customers. Specifically, not just when they buy from us, but also during sourcing decisions and after the purchase, which means along the entire customer journey. Coffee beans are a commodity. The ready-to-serve coffee in the Styrofoam cup can be a service. But drinking coffee only becomes an experience for customers when they associate positive impressions with it. That's when they are willing to pay more, too. Just what the experience could be for our customers when they look for, buy and process materials is what we are currently developing for several of our product groups and markets.

————— Balaji Ravi

What mattered was what we brought to the table as persons, and in my view, the capacity for abstract thinking ranks at the top. Why? Because the assessment of ideas is about looking beyond details and finding a solution space for the core idea. People who are quick on their feet are clearly at an advantage!

————— Arno Plankensteiner



\$2.00-\$5.00
Experience

Commodity to Remarkability

Quelle: Pin & Gilmore
·Experience Economy·

We have limited access to rare earth metals

I struggle staying up-to-date on latest research trends.

What were some of the things you had to adjust to?

There were no supervisors in the traditional sense in our project, but rather coaches for a wide variety of topics. As a result, we were constantly working on different teams. If we wanted to participate in a work group, we had to take initiative ourselves; nobody asked us. All the information was stored on open systems accessible by all of us.

————— Balaji Ravi

And yet, there was this invisible hierarchy. There will always be a time in a project where a decision has to be made. The decision maker then takes the helm, and everyone gets on board. These decision makers don't stand out because of their personal superficialities, but because of their in-depth knowledge of the project supporting their focused decisions.

————— Arno Plankensteiner

It's hard to find suppliers to help in co-creation.

How was the working relationship with the teams from BCG?

The diversity of the employees who assisted us was impressive. It was also striking how many women with a technical background work for BCG. The mixture of technical and non-technical experts is also incredibly interesting. For example, we worked very closely with a fashion designer. Just like we at Plansee ponder materials and their properties, the fashion designer mulls over fabrics and their structures and textures. This elicited very diverse thought processes and interesting associations.

—— Elisabeth Eidenberger-Schober

To me, it was impressive how quickly you grow together as a team by working closely together. We always worked face to face with each other on the creative development of ideas and strategies, almost never called each other on the phone. We had a pronounced culture of dialog and discussion, and a high level of sensitivity for what every member on the team can contribute. Everyone gets a chance to speak and is allowed to finish their thought. Comments were sent per chat. The project's progress is readily available at any time – it would be inconceivable for some tasked with an assignment to hole up in their office for a few days or weeks and just work quietly on their own. At the same time, if someone for whatever reason does not fit the team (any longer), he or she is immediately replaced.

—— Arno Plankensteiner



The vetting process for new suppliers is time consuming.

We quickly adapted to our partner's culture and have begun a joint journey to explore new ideas using BCG DV's navigation tools and structural methodology. The overall setting has indeed successfully built an incubator for developing digital ideas and fostering a creative environment that has enabled us to achieve ambitious goals. Senior staff at BCG DV provided on-demand, hands-on guidance, facilitated frequent reviews, and jumped in without hesitation when project went astray or incurred significant challenges and unexpected turns.

—— Vlad Ocher

And after work, it's into the ocean to surf.

Many colleagues from BCG DV actually did. The working hours are truly very flexible. Some indulge in their leisure time activities first thing and show up for work late in the morning; others leave early in the afternoon. As the customer and Plansee representatives, our job was slightly different. We had to be available to our contractors throughout the day. Besides, the ocean was definitely too cold. We did experience a lot though: Disneyland, concerts, Universal Studios and much more.

—— Nadine Kerber

We need material experts to challenge the mindset of our engineers

It's hard to find the right material and design for my application.



A promise



from an app

How Plansee Hochleistungswerkstoffe learns to develop new business models for selected product groups.

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——— Admittedly, it is not exactly easy to adopt the models for success from Silicon Valley's hip software firms. This holds especially true for a material and tool supplier such as Plansee and its decades-long business model of delivering outstanding products made of tungsten, molybdenum and hard metal – no less, but also no more. At the same time, the world does not stop turning ... so let's first take a look at the past.

——— The old world was all about developing a product. If you thought that the product was good enough, you took it to market and started to look for customers.

——— The motto at Plansee often was: Once you get a customer drawing, manufacture the product as best you can. Durability and quality are top priorities, price and lead times are (almost) irrelevant.

——— But what about the new world? It is all about creating an app and coming up with the promise of a product. You discuss with the customer whether a need exists. And if the customer indeed expresses an interest, you give some thought as to how you can actually supply this product.

——— This is precisely what various teams from Sales, Logistics, Development and Service have done in recent months. Their goal: creative destruction. To develop new business models before someone else does. To protect our own business by offering greater or added value to the customer – by offering more than 'just' products, services and logistics, and more than quality, flexibility and speed. This is about new avenues and forms of collaboration. Initial project groups have formed to explore topics such as: How do today's developers locate molybdenum and tungsten materials when they are looking for certain material properties? How can we support the life cycle of products used in medical technology or high-temperature furnace construction? And how can the regrinding service for hard metal drills be optimized?

——— To pursue the questions outlined above, Plansee above all needs data, data, and more data. How are the products used in the end customer's application, or what stresses will they experience? What is the condition of the product after a certain number of operating hours? How often can it be reconditioned and reused?

*If the customer says »Wow ...
I want to know more about this concept!«*

**The wallet exercise:
design your partner's wallet.**

We use this 30-minute exercise to become attuned to design thinking. This is how it goes:

Test Feedback
Evaluate opinions and criticism

Step 6 Jointly test the prototype and collect feedback.

(Re)Define
Try it again

Define the Challenge

Step 1 Find a partner and have him/her show you his/her wallet.

Interview Understand

Who?
Why?
Where?
What?
How?
When?

Step 2 Find out as much as you can about the user and the wallet.

Synthesis Point-of-View
Definition and goal

Step 3 Briefly summarize key findings and discuss them with the partner.

The method: Design Thinking

This is an approach for solving problems and developing new ideas. The objective is to find solutions that are compelling from the user's perspective. The method is based on the assumption that problems can be better solved when people from different disciplines work together, jointly tackle a problem, take the needs and motivations of people into consideration, and then develop concepts. The method uses a designer's work for reference, which is considered to be a combination of understanding, observation, brainstorming, refinement, execution and learning.

Prototype Build
Implement one idea with the help of a prototype

Step 5 Create a prototype using simple means (paper, scissors, glue, etc.).

Ideate Brainstorm
The more ideas the better

Step 4 Develop rapid ideas on improving the wallet.



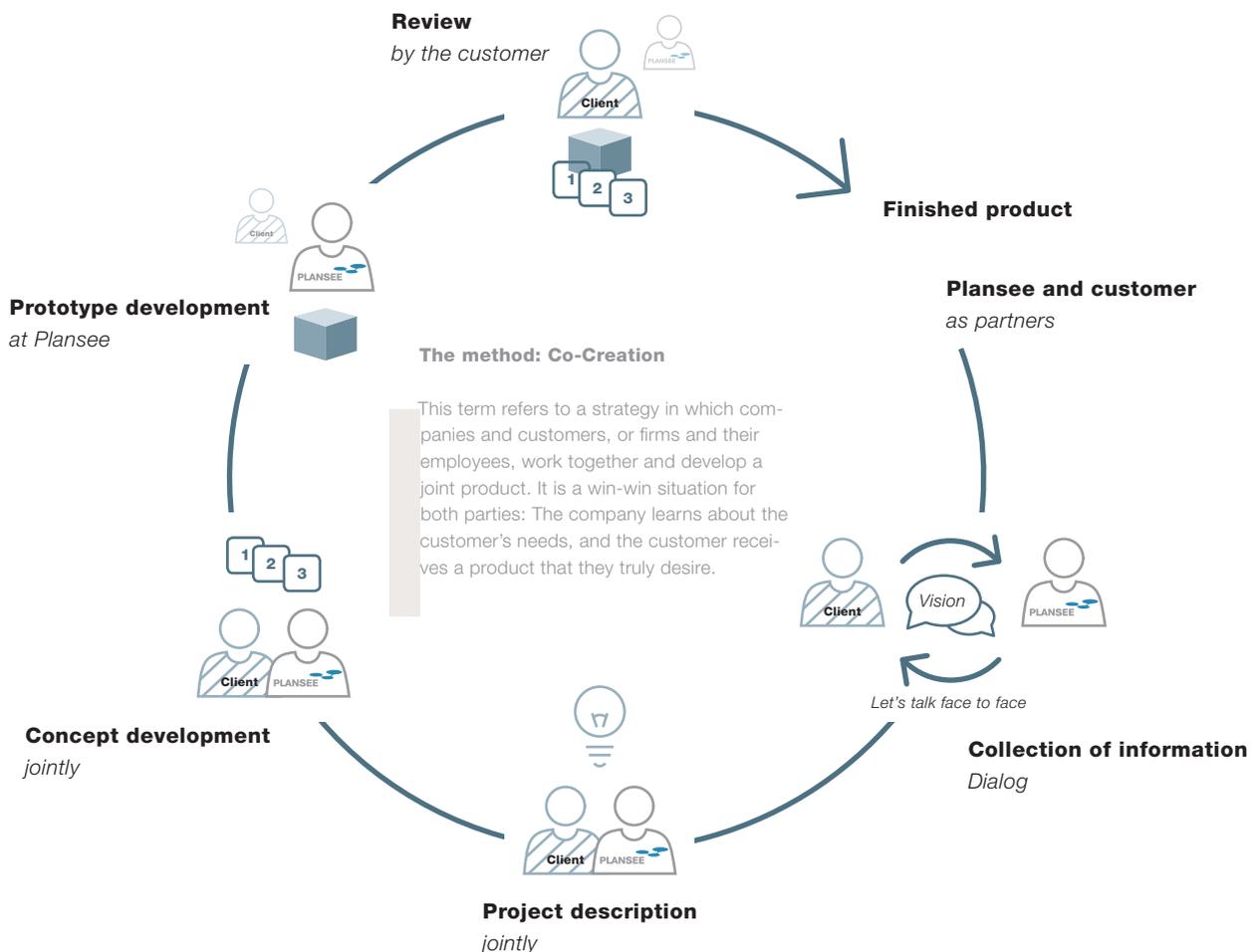
——— This data allows interesting conclusions to be drawn: Is there a connection between wear and production parameters? How much does an operating hour cost the customer? And how could the product be optimized to lower operating costs?

——— These findings are the precondition for offering the customer new business models. It would be conceivable, for example, to transition from selling the product to selling operating hours.

——— It is true that these assumptions initially are, above all, a distant dream, and it is anything but certain whether their implementation will be this way or similar. But it is also not unlikely. And there is a reason why, which is the method that has led to the results. It combined the best of two worlds: the rapid, lean and cost-effective procedure of a start-up, with the broad knowledge and extensive experience of a major company, such as Plansee.

- Ideas, project goals and success factors are developed in fast-paced workshops.
- Then comes the first stress test: Conducting detailed interviews with external experts, customers or logistics partners, the project teams ask crucial questions about the further course of the project: Are our assumptions correct? Does the market indeed work this way? Does the market need what we have come up with behind closed doors?
- The discussions are not only logged, but also put on paper by a professional draftsman who translates the future business model into clear and striking drawings, making the ideas concrete, tangible and transparent for everyone. The illustrations are extremely helpful in explaining ideas to colleagues and customers, and in convincing them.
- Based on the feedback, the first minimum viable products (MVPs) are developed - products with minimal requirements and properties.
- This is an emotional and easily comprehensible way to present the new business model in an app, which invites the viewer to try it.

——— This MVP is introduced to select customers. If the customer is open to a dialog, the process results in a close working relationship oriented toward enhancing and implementing product ideas jointly with the customer.



1. Identify the constraint

»We want to be the world's best hard metal factory for our customers.« This was the declared goal of Ceratizit Austria just over ten years ago. Find out where the company stands in terms of its goal – and what it has planned going forward.

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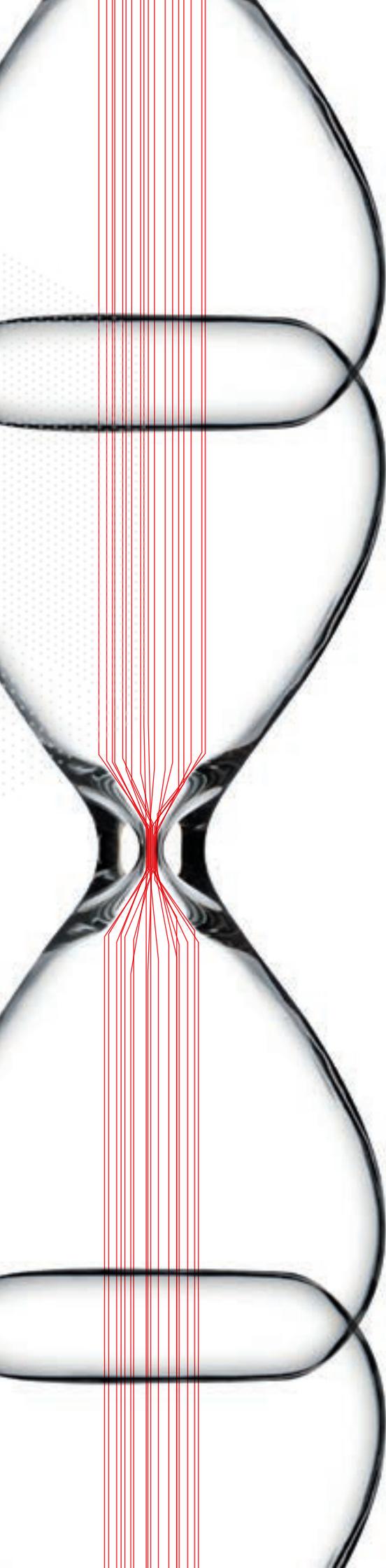
Make the market
the bottleneck.

——— Ten years ago, no one would have expected that Ceratizit, the dwarf among metal cutting tool manufacturers, would effortlessly slip under the radar of major competitors. The company's management took this situation in stride and geared the entire firm toward competition and growth.

——— Not only the ambitious goal of becoming the best hard metal manufacturer, but also a new management and manufacturing philosophy played a crucial role in its success. While the old system was based on hierarchy, a silo mentality, rigid rules and a predominantly inward focus, the introduction of the Theory of Constraints (TOC) management and production system brought with it comprehensive and very effective change.

But how to set this change in motion?

——— The banking and financial crisis in 2008 proved helpful in the company's efforts. Order volumes abruptly plunged, and employees had to be let go. But orders flooded back in just as quickly, threatening the company's ability to deliver. Bewildered, they couldn't believe their eyes and resolved to position the company with such flexibility and adaptability that it could respond to changes in the market much more quickly.



2. Exploit the constraint

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A strong vision for the future set the course

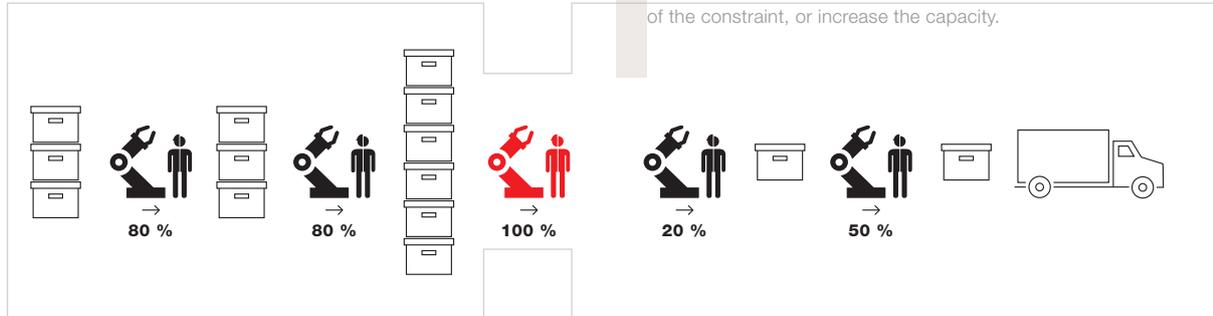
———— Ceratizit Austria was to become an agile firm with appreciable competitive advantages. Without the burden of day-to-day operations, management had to strategically develop the company. Preconditions included transparency, clear key performance indicators, and a good communications culture. The objective was for every employee to be aware at all times of current limitations (constraints), which must be eliminated to allow the company to operate more successfully.

The method of choice was the Theory of Constraints

———— TOC is aimed at boosting the company's throughput by subordinating the entire organization to the constraint, becoming synchronized with the market, and focusing on exploiting these bottlenecks or, ideally, eliminating them. Constraints can be of an external nature (market demand, customers' needs) and of an internal nature (set-up times, machine uptimes, inefficient processes). The goal of continuous optimization is to always keep slightly more in-house capacity available than is in fact needed by the market. In other words, the market forms the constriction in this situation, and sales is doing its utmost to make the most of this bottleneck. As a result, the company can offer its customer the best possible service, even during times when market fluctuations are on the rise and planning for customer demand becomes increasingly challenging.

Theory of Constraints

While the bottleneck has a 100 percent utilization rate, the system as a whole, such as a production line, is operating below capacity. If too much product is pushed into the system, too much product is in progress concurrently, and goods will pile up at the constrained area. What to do? Limit the amount of product that is pushed into the system to what can be processed at the constraint. Then work on improving the utilization of the constraint, or increase the capacity.



Internally, another distinction is made between strictly physical choke points, such as machines, staffing or qualifications, psychological hindrances, such as dysfunctional leadership conduct, mental blocks or the inability to change, and policy constraints, such as focusing on wrong key performance indicators and the resulting management decisions. Only when these different limitations are transparent at all levels and at all times can conscious operational and strategic decisions be made.

Overcoming constraints

To optimally capitalize on physical drags on production, these were trimmed for greater efficiency using appropriate lean practices. New recruits and training programs ensured that employees in critical areas were better equipped for their job. Service areas, such as maintenance, were integrated via a priority system to re-establish the productivity of machines as quickly as possible in the event of downtimes.

The development of shared leadership principles and subsequent group and shift supervisor training played an essential role in overcoming psychological constraints. The key here was to create a uniform leadership understanding in the spirit of the aspired changes, and to empower senior managers to create a sense of purpose, fill employees with enthusiasm about the new management and production philosophy and, above all, to foster ownership and action by every stakeholder.

While initially the focus was directed at converting one production line to TOC, questions quickly arose as to what to do with upstream and downstream functions. The company quickly realized that all processes are interrelated and, as a result, must be addressed all at once. This included the following topics:

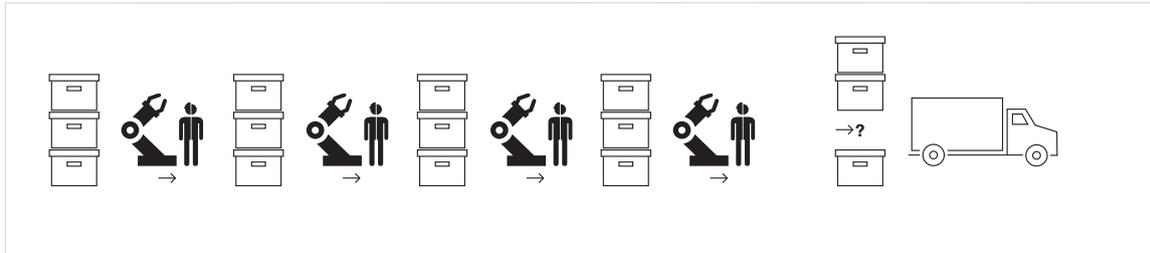
Definition of the key performance indicators

An important exercise consisted of gaining an overview of key performance indicators used within the company, followed by the question as to which indicators are useful, and in what departments, in the first place. After all, the goal must be that every employee only encounters key performance indicators that quickly answer his or her question whether it influences the company's success, and how. Sales and profit are most definitely important parameters for the managing director. The manager of the production line may ask: How many tons of product do I manufacture over a certain time frame at the bottlenecks? How can I cut the turnaround time of a product? And employees must know what sequence of orders to follow, how to minimize idle times, and whether the quality is good.

4. Elevate the constraint

3. Subordinate everything else to the constraint

The objective is for every employee to be aware at all times of current limitations (constraints), which must be eliminated to allow the company to operate more successfully.



Introduction of standard communication

Communication in the company must not be an end in itself or left to chance. Rather, communication procedures are incredibly important to establish new behavioral patterns. These include structured transfers after every shift, the documentation of quality issues, and regular department meetings. In terms of the desired conduct, employees get to the bottom of problems where they can be solved – which is directly in production. The result: fast solutions. This curbs the deluge of e-mails and endless coordination loops, easing the burden on supervisors such as team and group leaders.

Daily improvements at the PDCA Center

PDCA refers to plan-do-check-act. In the effort to continually improve the best utilization level of constrained areas and the flow principle at non-bottlenecks, all production employees note on a card every problem preventing them from optimally working. These cards are evaluated, prioritized and forwarded to the persons in charge on a daily basis during production walkthroughs. These individuals attempt to thoroughly explore the topics and find solutions. This process works across departments. For example: When work instructions or drawings are not correct, these cards are forwarded to Production Planning or the Design department, where they are promptly remedied, and feedback is provided about their completion.

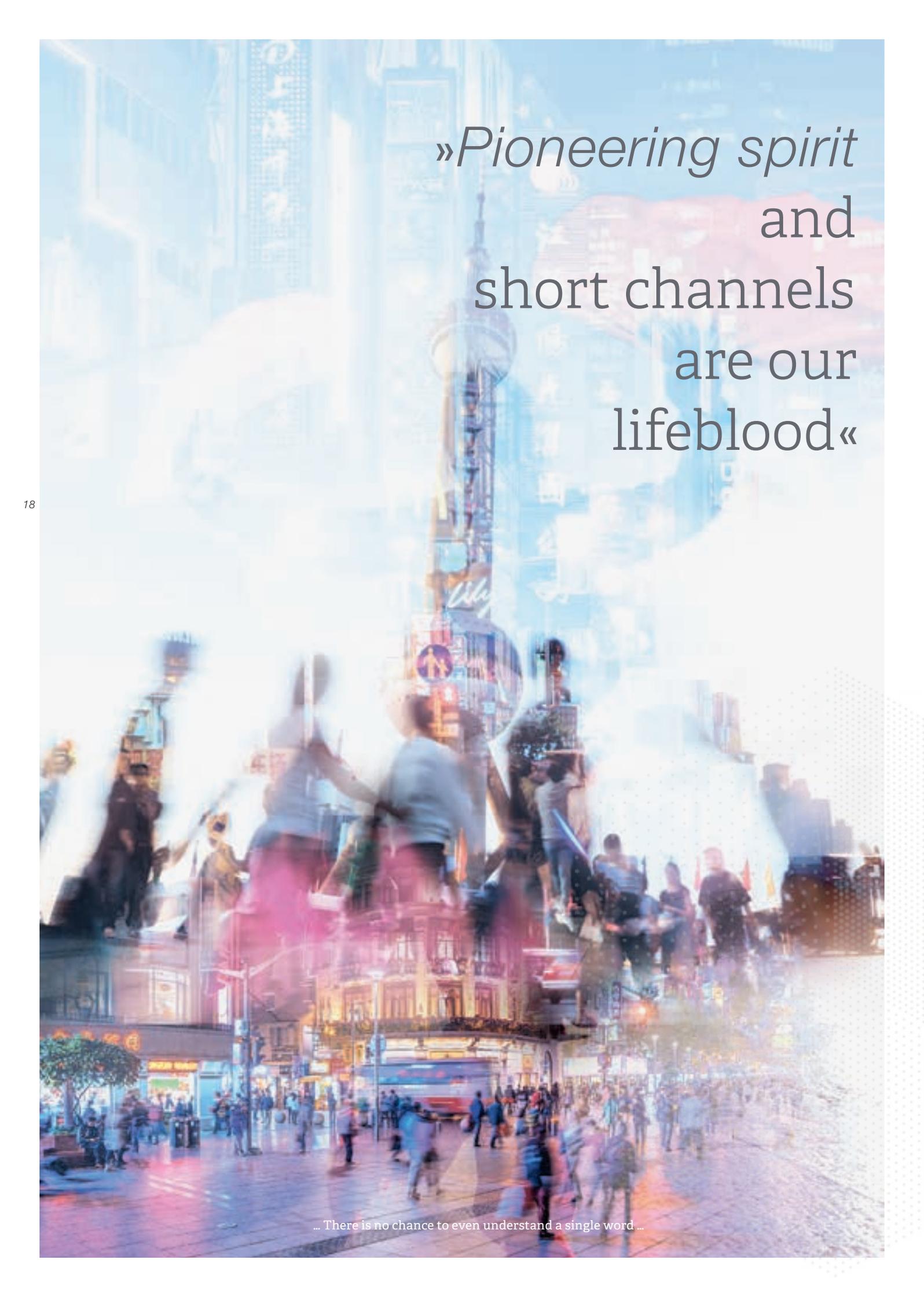
Ceratizit Austria also recognized early on what topics such as digitization, automation and Industry 4.0 truly are about in the context of the TOC management and production philosophy. The crucial question is: Does the business model primarily serve the direct benefit of the customer, and will it do so in the future? Only when the answer is a resounding 'yes' does it make sense to automate the appropriate processes.

By frequently asking the question as to what stands in the company's way of generating maximum customer benefit and value, precisely those processes are automated which create the greatest benefit from the customer's perspective.

Only then can Industry 4.0 enhance efficiency in production and sales.

At the same time, process automation and structured data collection create the foundation for linking this data in a meaningful way, drawing conclusions, and sensibly enhancing processes.

5. Go back to step 1



»Pioneering spirit
and
short channels
are our
lifeblood«

Even at the age of 16, Christine Toufar was intrigued by powder metallurgy. Some 17 years later, she now heads up the development department of Plansee Shanghai.

This is a dream-come-true for any technology firm: a young girl who is eager to pursue a career in powder metallurgy.

This is indeed true. At the age of 16, I participated in the Chemistry Olympiad, a program that supports young individuals interested in natural science. In preparation for the event, we visited a former fellow student of my chemistry teacher at the Vienna University of Technology, Professor Wolf-Dieter Schubert, and this was my first exposure to tungsten powder metallurgy. I was very impressed with tungsten as an element of extremes, given the fact that it has the highest melting point of all metals. I also found it fascinating to learn that solid metal materials could not only be produced by melting them, but also by using powder metallurgy. I decided that this would be my profession, and at university I didn't study regular chemistry, but technical chemistry.

I then wrote my thesis and dissertation with Wolf-Dieter Schubert. I covered a very wide field ranging from tungsten trioxide to hard metal in the dissertation for Wolfram Bergbau und Hütten AG in Bergla, Austria.

You started to work for Ceratizit in Reutte even before completing your dissertation.

I was familiar with Ceratizit long before that. Additionally, one of my fellow students wrote her dissertation in cooperation with Ceratizit in Mamer, Luxembourg. To me, it was the best company I could imagine for starting my career. Ceratizit has an excellent reputation in the industry. And then there is its size: It's large enough to offer development opportunities for employees, yet small enough to make a difference. I never wanted to work in a big corporation, where the development department is miles away from production. To me, they belong together. When a vacancy in the development department for hard metal rods and formed parts was advertised, I immediately applied, and was accepted right after my interview.

At Ceratizit, you worked in development for almost four years, until one day you received a call from HR ...

... the head of Human Resources Udo Fichtner called and asked whether I was interested in a position in China.

Where you shocked?

Not at all. But I was very surprised. I have always been interested in Asia, but it was very difficult for me to leave Ceratizit. Still, eventually I got to the point where I told myself: I'll just simply do it and take the plunge.

» **Every one of our employees has the opportunity to apply for jobs at our international locations.**

«

Udo Fichtner
Head of Human Resources

The time between signing the contract and packing your suitcase was only six weeks ...

... which were extremely busy. The new job was the result of a major contract Plansee had garnered just a short time before. Now they were looking for a technical project leader for setting up an additional production line in Shanghai. I had two very intense onboarding weeks at our plant in Lechbruck, Germany, which was manufacturing comparable products. And I took Chinese culture training sessions. All this was helpful in giving me the feeling that I was prepared. Previously, I had only been to China on my 'look and see trip'.

So you were still taking the plunge.

That's correct. I had no clear idea of what was awaiting me. The new production equipment arrived in Shanghai the same time I did. My colleagues and I rolled up our sleeves and got to work. We had two months to turn these pieces of equipment into a functioning production line for the mass production of heavy metal parts – from pressing, to sintering, to finishing. The biggest difference compared to my work at Ceratizit was that Reutte is a site that was established decades ago and has well-honed processes. They have an experienced specialist on just about every topic. We have tremendous people in Shanghai, no doubt about it, and we have also since grown our team to a staff of more than 200 people. At the same time, we have no pool of experts, and we were dealing with production technology that was new to the facility. The colleagues from Reutte and Lechbruck were awesome in supporting us with their knowledge and experience.

Of course, there were situations where we were on our own and forced to improvise. With a lot of personal commitment, the courage to pursue new avenues, and a general, purposeful approach, we managed well.

Is the customer satisfied?

This project was an excellent test of the capabilities of the Plansee Group. Not only did we manage to satisfy the quality, flexibility, pace and adaptability to new requirements our customer was looking for, but we also worked very well together as a group across the locations. It was a one-of-a-kind project that was a lot of fun, and not only the customer, but we too are satisfied with it!

And it also paid off for you personally – you took the next step in your career.

As of March 1, 2017, I have been heading Plansee's development department in Shanghai. This primarily includes product development for the Shanghai site, but also the ongoing development of our existing manufacturing technologies and the localization of new ones. Pooling the development talent in a dedicated department sends a strong signal: We want to move forward in China at full speed and support the location's great development.

Do you already know Chinese?

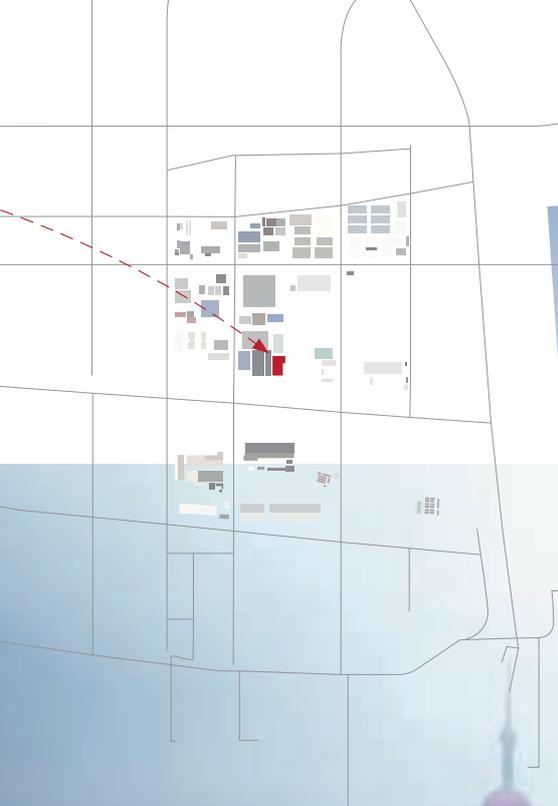
I made an effort to learn the language, but had very little time during the first year. I have strongly resolved, though, that I won't leave here without basic knowledge.

So how does the communication on the team, with the employees, work?

I was very fortunate to work on a team that functions very well and where everyone works toward a common goal, even if we have discussions at times. I definitely consider this to be positive. We can only overcome the challenges we are faced with every day if we work together. This bonds us. We get along well, trust each other, and don't take different professional opinions personally.

Something I found difficult in the beginning was the approach to tasks of the people here, which at first glance appeared chaotic at times. Dealing with this required a different work style and a healthy portion of composure. Over time, I realized that 'making things simpler' can not only be beneficial, but might be necessary from time to time in the dynamic environment we work in. Combining this with a more European-structured approach is efficient and target-oriented.

In terms of linguistics, the colleagues I work with directly speak English. Our plant employees, however, only speak Chinese for the most part. Oftentimes someone will translate, or I have to get creative. Somehow we always manage to communicate – either with translation apps, or non-verbally through wild gestures ... After all, I do speak a few words of Chinese already.



»Additionally I am very fortunate to work on a team that functions very well and where everyone works toward a common goal.«



How do you like Shanghai?

Very well. I find Shanghai to be a western-oriented city with astonishingly good infrastructure. Tolerance and openness are more pronounced here than in Austria or Germany. What I like incredibly well is the enthusiasm and ability to adapt shown by the Chinese. At the same time, Shanghai was an entirely new environment, a challenge. I had no personal contacts, and additionally I was not able to speak the language or read the characters. There is no chance to even understand a single word. But the Chinese were very patient with me when, in the beginning, I didn't know how things worked here. Personally, I continue to miss services like Google, Google Maps or YouTube.

You prepared for your assignment with cultural training – how helpful was it?

Cultural guides are true on some things, but certainly not in every respect. One of the things I learned during my cultural training was that the Chinese are not helpful outside their circles, and that they cannot say ›no‹. I very quickly revised this assessment.

It is also difficult to apply rather abstract pieces of wisdom to very specific situations, such as product development. This is where I learned how different our Chinese or Asian customers are. In the extreme case, the fabrication of a prototype formed more the start of a successful collaboration, rather than being done the end – even if, based on experience, we would recommend and discuss a different design or material. I had difficulties with this approach initially, but I quickly realized that it isn't worse, just different. First, we work on the relationship and demonstrate that we want to do something for the customer. We can always talk about the design or material later, since the first prototype doesn't have to correspond to the later solution. This is also a learning process for us.

Additionally, they attach a lot of importance to the design. The product has to look really good. In Europe, in contrast, functionality is the top priority.

Is there something you can't cope with at all?

A constant hectic pace, loud noises in all walks of life and occasional ruthlessness behavior outside the before mentioned personal circle of relations. This is exhausting for me.

What drives you?

I want to make a difference. I work in a young and relatively small plant, with a tremendous team. Pioneering spirit and short channels are our lifeblood. We work in a tough competitive environment. We have ambitious plans for growth and expansion. And we receive excellent support from our sister factories in Europe. All of this is extremely exciting and motivating!

»... the company is large enough to offer development opportunities for me as an employee.«

»I love Reutte,

...but I'm
ready for
a change of
scenery!«

TOWANDA

*Relocating from Tyrol to Pennsylvania gave
Claudio Redaelli's career a big boost.*

1999 Degree: Georesources management
Poltecnico di Milano

2006 Internship:
Ceratzit powder manufacturing

2007 Process Technician:
Ceratzit powder manufacturing

2008 Technical Manager:
Ceratzit recycling plant



What did you study?

When I was faced with the question of what to study in my native northern Italy in the late 1990s, I opted in favor of environmental technology and mechanical engineering, majoring in Georesources Management.

Why Georesources Management of all things?

It was the discipline that the fewest of my fellow students were interested in. And it was the only engineering degree that involved topics about the Earth and above and beneath its surface. My dream job then was to work on an oil drilling rig.

What positions have you held so far in the Plansee Group?

I started with Ceratzit Austria in Reutte, Austria, in 2006. I applied for an internship and started in Powder Preparation only four days later. One year after that, I was hired as a Process Technician in Powder Preparation. In 2008, the recycling factory entered very exciting times. We started with the first furnace back then and set up the processes. Four years later, the pool had already grown to a number of furnaces in which tungsten scrap is recycled into high-grade raw material using the zinc process. Today, the Plansee Group is the world's leading HM Scrap recycler through the use of the zinc process.

Despite your initial experience, you tested the waters for the USA as early as 2010?

In 2010, Plansee Group had a posting for an engineer in Towanda for fuel cell production, which was still a relatively young operation. I'm always curious and wanted to gain an understanding of what it means to work in the US, therefore I applied. I went to the interview in Towanda, but the economic crisis was a game changer and the position went unfilled. At that time, I was happily continued working in Reutte on setting up new furnaces in the recycling factory and optimizing the processes.

That is, until a new opportunity presented itself in 2011?

In 2011 a new opportunity presented itself for an engineering position in Ready-To-Press Powder formulations at which time I was contacted by GTP Human Resources. I already knew the process from the powder manufacturing operation in Reutte and thought to myself: I have to say 'yes'; it would be foolish to turn this down. I love Reutte; but was ready for new change of scenery. Off I went, using the knowledge I gained in Reutte to improve and enhance the powder production processes in Towanda. Shortly thereafter, I became Process Engineer for APT. This job required a whole new level of responsibility and understanding of the process. The plant operates around the clock, and every mistake is expensive.

RED ROSE DINER

And it wasn't long before the next opportunity in your career developed?

In 2014, production in Towanda was being reorganized and I was asked if I'd be interested in becoming the Product Line Manager for Ready-To-Press Powders and Thermal Spray Powders. For the first time, I was also supervising employees, in addition to being responsible for equipment and processes. Additionally, as Manager, I had to work with a number of other departments. On top of this, the company had set the ambitious goal of further streamlining powder production to maximize efficiency in light of the slump in the raw materials markets. In other words, they wanted to boost throughput and cut fixed costs to keep the price of their product competitive.

Most recently, I was given an opportunity to work in international marketing as a Business Segment Manager for hard materials. This is an entirely new challenge. I can't wait to see how I can apply my technical background in a sales and marketing setting. Our products are so complex that my technical background is a prerequisite to be able to have a dialog with the customer on an equal footing.

**D
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How are you able to take on new challenges time and again?

I have never been afraid to ask questions. I'm convinced that there will always be people who know more than I do and I learn how others are managing their work: how they handle their e-mail, how they speak with employees, how they organize their work day. I try to compare this to my own approach to work and adopt the best techniques. I was fortunate to have many mentors who were good leaders and role models.

What is different in the USA compared to Europe?

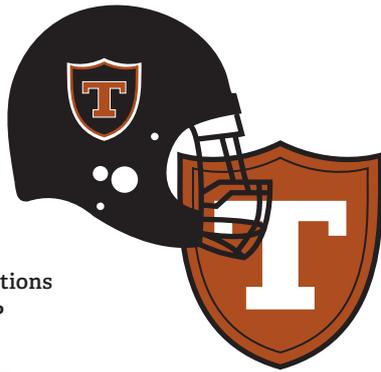
I have the impression that the people in the US are very open to change. This is very much expressed in their attitude: the respectful way they speak to each other at every level; the openness to listen to the opinions of others; the chance to share one's ideas and implement them.

OPEN

The USA is the third country in which you have lived and worked. How do you adapt to the new environment?

I enjoy living in different cultures. I travel a lot privately too; not to all-inclusive resorts, but to places where I have a lot of contact with other people. I find it exciting to get to know the language and the culture, to learn how other people think and act, and how they deal with challenges and problems. Just to mention one example: In a new place, you start from scratch. Where do I buy my bread, where are my colleagues' offices, where is which production area located? You have to be curious and have an explorer mentality. Everything is different.

»... the only engineering degree that involved topics about the Earth and above and beneath its surface.«



Has working in different locations advanced your development?

Yes, definitely! International experience is a tremendous opportunity. I'm convinced that every position I have held in the Plansee Group in the past prepared me for the next task.

What does success mean to you?

I find it difficult to put criteria for success down on paper. To me, it's more the attitude to personally develop, and to give what you're doing your best. To accept the challenges in life and work, and to use these experiences to take the next hurdles. When I feel as though I can achieve something, I want to actually achieve it, no matter how much work it takes. I want to climb as high as possible, and this isn't really about money.

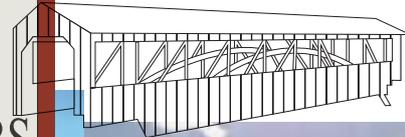
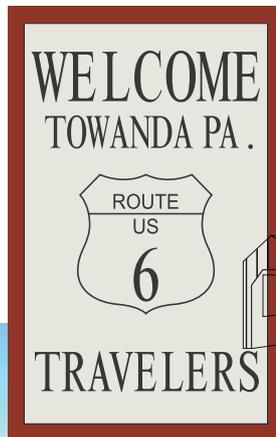
If you had the chance to start all over again, what would you do differently?

I don't think that I would do anything differently.

How would you convince a colleague to agree to a stay abroad?

By compiling a list of all the exciting, amazing and fun experiences I have enjoyed so far.

2017 Business Segment Manager:
Business Segment Hard Metals GTP

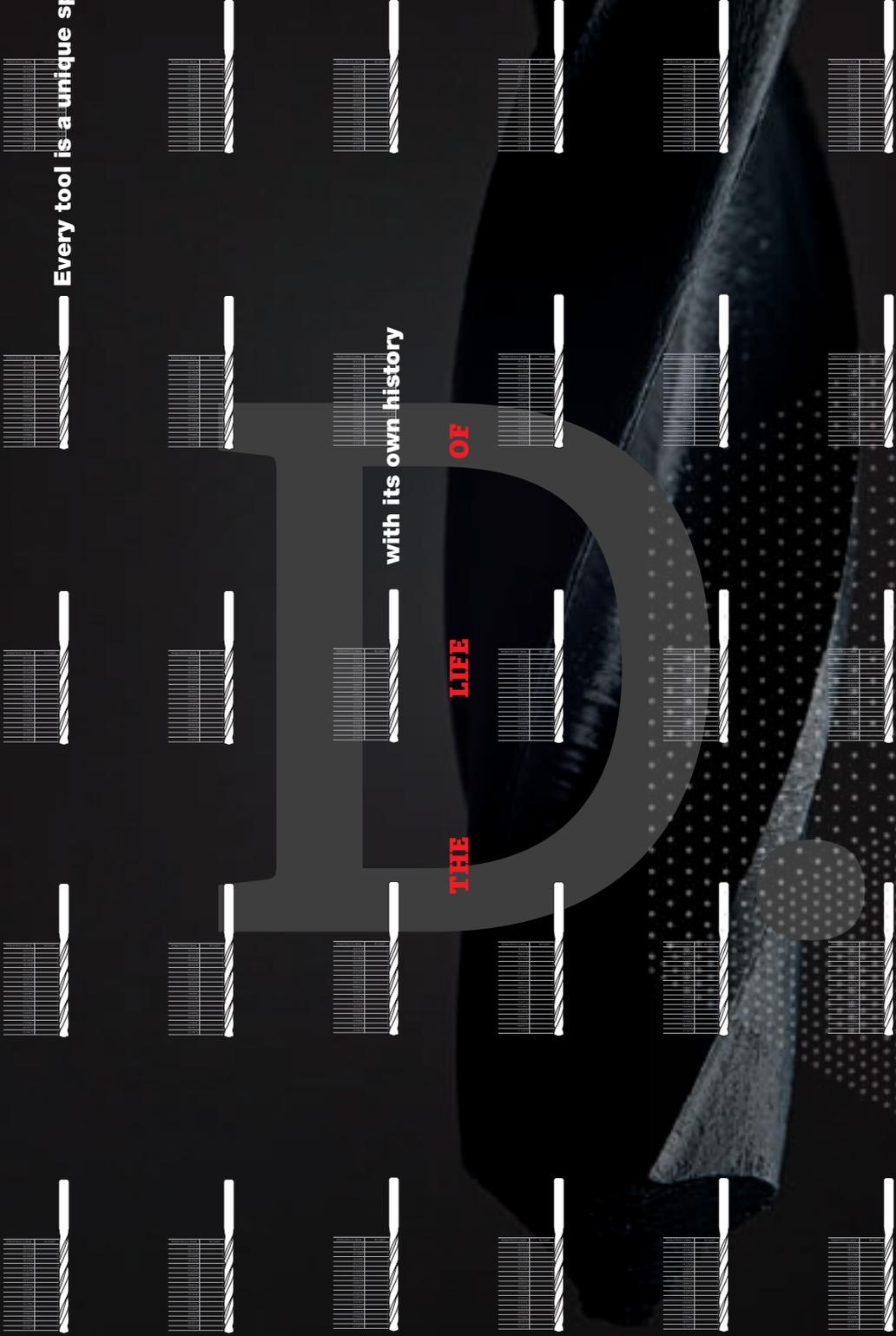


»Everything is different.«

Every tool is a unique specimen

with its own history

THE LIFE OF



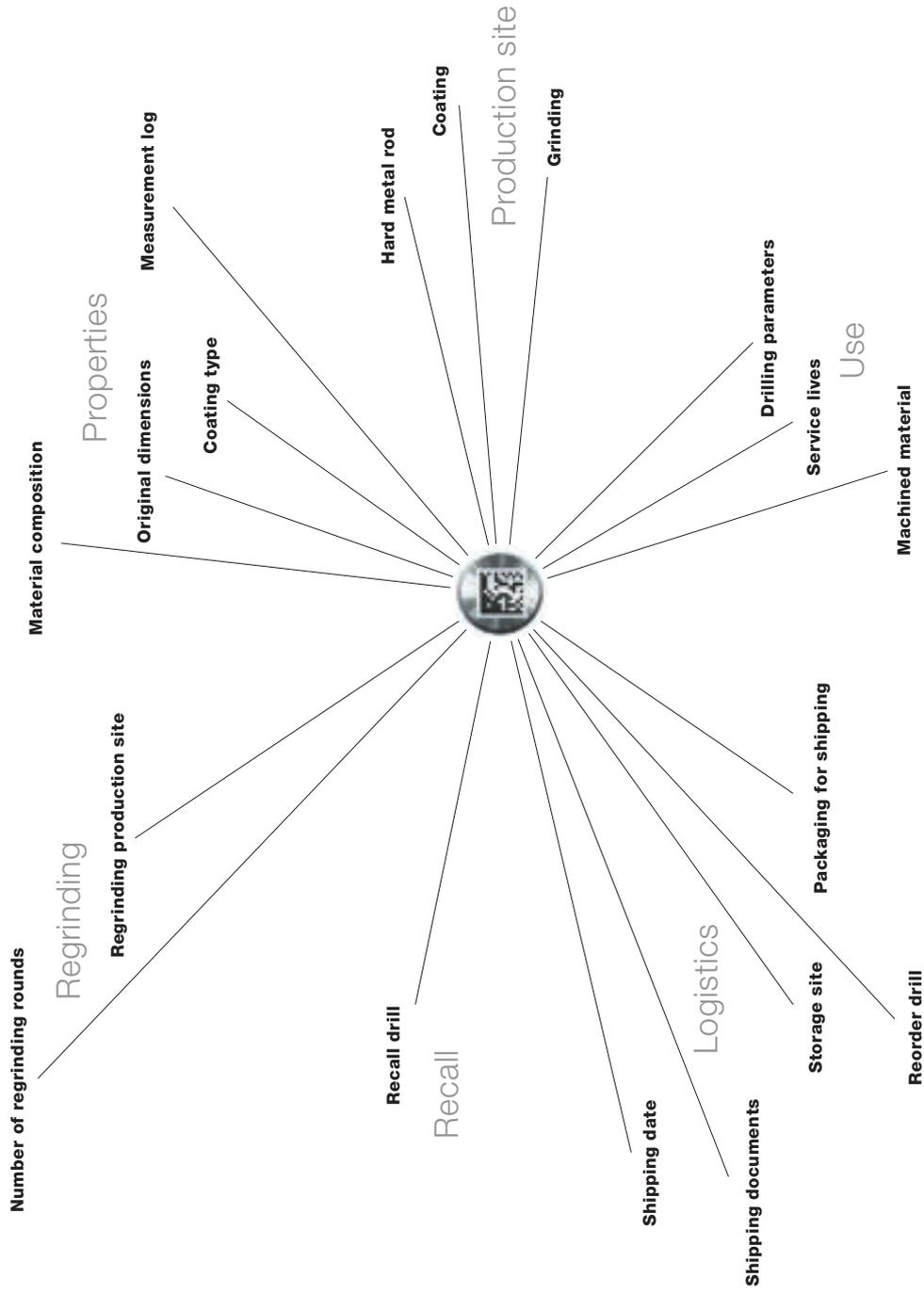
Even before D. was a drill, he was one-of-a-kind. Bearing clear identification, he started his life as a drill. Scanning his code will tell D.'s life story. If D. should ever need regrinding, this can now be done significantly more quickly and better, and with much greater transparency.

———— On cars, the practice has been a matter of course for more than 30 years: Each vehicle is clearly labeled with a vehicle identification number (VIN), an internationally standardized 17-digit serial number. This brings with it advantages, for example in the repair shop. Service managers can see at a glance what work and repairs were previously conducted on the vehicle.

———— What has proven useful for cars, could also be a good thing for solid carbide tools – like our drill D. Because the only thing we know is that the life of D. is full of secrets. Where was D. produced? What is the material composition of D.? How was D. coated? How often was D. sharpened? What drilling applications was D. previously used for, and how long?

———— To be able to answer these questions in the future, the companies within Ceratizit Group have implemented a unique identification scheme for tools.

———— The idea is to assign a unique number worldwide to each solid carbide tool, making it distinctive and identifiable at all times. »By marking it with the number, every tool becomes a unique specimen with its own life cycle and an individual history« comments project manager Jochen Metschke at Ceratizit Logistik GmbH in Kempten, Germany. The goal is to establish a standard in the tool industry and create a network among all companies involved in the value-added process – from the creation of the product, to regrinding, to recycling.



———— The companies of the Ceratizit Group, which also includes Günther Wirth and WNT, unveiled the concept in September 2017 at EMO in Hanover, Germany, the world's leading trade show for the metal working industry.

———— And this is how the information system works: A laser engraves a data matrix code consisting of a unique number into the shank of the tool, which later becomes drill D. From this point on, the tool has a unique identity. This identity is stored in the cloud or on company servers, and all steps that follow during the life cycle can be associated with this number. This includes subsequent manufacturing steps, such as grinding and coating, but it is also possible to control logistical aspects via this number. Where is the tool stored? How does it have to be packaged for shipping? When was it shipped? All this information can be accessed at any time by scanning the data matrix code. It is also possible to form batches by combining several individual products in one number, for example to automate incoming and outgoing goods processes.

———— In the system, it is possible to link RFIDs, QR codes or any other ID with the unique numbers – the choices are virtually limitless. Additionally, other systems can be easily integrated via interfaces, and even machines can be connected to the system by a simple interface development and included in the communication. This allows machine tool operators to link key data, such as equipment run times, machining parameters and a whole host of other information, to a certain tool and to develop concepts that enhance productivity by appropriately evaluating the data.

———— In the past, a worn solid carbide tool prompted a complicated process, where the tool was sent to a regrinding facility, measured, and then reground. This will be much easier in the future. All it takes is a scan of the data matrix code of D., and the regrinding facility is able to access the tool's original dimensions. A fully automatic decision-making process determines whether regrinding is worthwhile and, if so, the proper regrinding program is selected. If regrinding the tool is no longer possible, the tool is appropriately recycled based on its material composition.

———— Despite all these advantages, data security and a tool's 'privacy' must not be compromised. »The system allows encrypted data to be entered, data to be encrypted and exchanged with other firms within a system, and read and write access to be defined at every level. In general, all data can be transmitted in encrypted form,« says Jochen Metschke.

W
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just in time.

Plansee produces a component from tungsten or molybdenum based on a digital customer drawing in a matter of days. Will Plansee use 3D printing to produce all tungsten and molybdenum products in the future?

An interview with Plansee technology expert Dr. Bernhard Tabernig.

Plansee has tailored the 3D printing process to molybdenum and tungsten. What kinds of components can this process be used for?

Our laser melting machine can produce complex, geometrically challenging components from molybdenum and tungsten.

How does a digital customer drawing become a product overnight?

The customer sends us a digital drawing, from which first of all we create a three-dimensional layer model by slicing the product into as many as 1000 individual layers. These are the individual layers used in the fabrication of the component in the laser machine.

Then our production process starts. We apply a layer of powder granules onto a bed. A laser beam melts the particles, building the component layer by layer – until it is finished.

The product is then removed from the build plate. A 3D camera is used to measure and digitize the product, which is then compared to the specifications from the customer's drawing.

What are the benefits of laser melting?

It gives us significantly more design freedom in the creation of products, and we are able to produce geometries that are not possible with traditional powder metallurgy. Additionally, there is no waste during production – every single particle of powder is used. We also don't need any tooling. And we are convinced that soon it will be possible to manufacture a large number of products considerably more cost-effectively by using laser melting.

What is the difference between traditional powder metallurgy production and 3D printing?

The traditional powder metallurgy production route starts by pressing the tungsten or molybdenum powder into the desired shape. This blank is sintered at high temperatures before it is further compressed in rolling processes. Afterwards, the products still have to undergo a machining step. These processes can take several weeks. 3D printing essentially requires only a single work step: selective laser melting. So far, the method is worthwhile for components with small quantities and relatively high geometric complexity. Simple semi-finished goods in large volumes, such as sheets, ribbons, rods or wires, will remain more cost-effective to produce via the traditional powder metallurgy manufacturing route for the foreseeable future.

Does this mean that we can now also print out all our refractory metal products?

This will still take a while. But it is, without a doubt, an extremely exciting technology. We want to make this process available for refractory metals on an industrial scale. We are in the process of developing powders and materials, as well as suitable testing procedures. Simulation helps us gain a fundamental understanding of the laser melting processes and advance them.

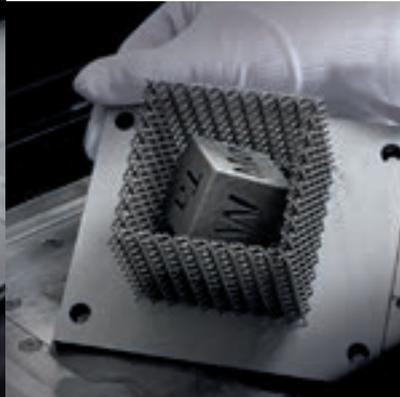
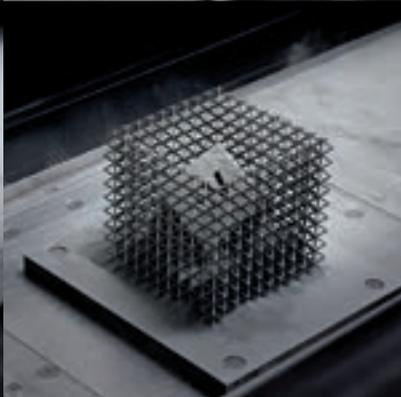
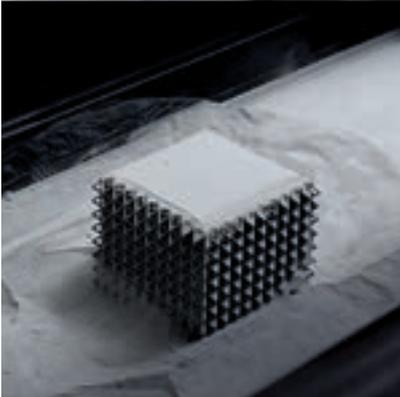
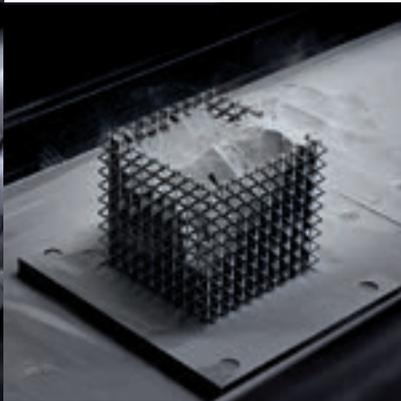
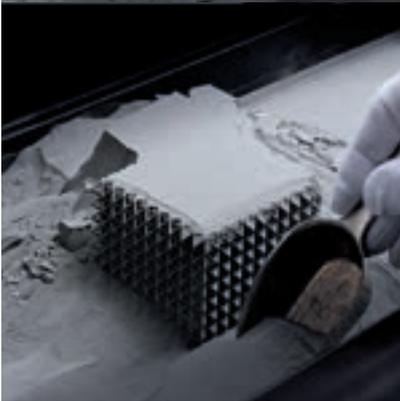
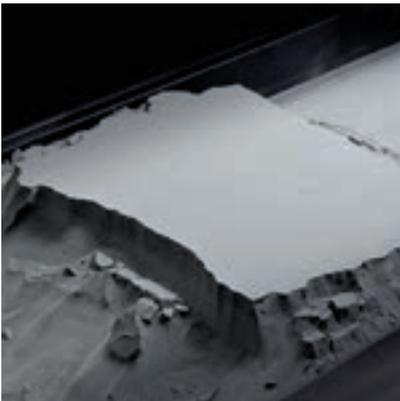
Let's assume I want to have an everyday item like a wrench produced from tungsten. Would this be a job for Plansee?

Yes, definitely. We measure the wrench with our 3D camera, prepare a digital layer drawing, and it's a go for production from there.

I can only encourage all customers to try our service. Whenever you have a product with a complex geometry and manageable volume – let's talk about it to determine whether we can have it printed for you in the future on the laser melting machine.

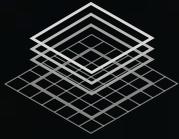
We had the title image for this issue of livingmetals produced on a 3D printer. How was this component created?

We received a briefing from the creative agency as to what the component should look like. Our CAD drafter Helmut Perktold converted these ideas into a 3D model. Originally, it was planned for the interior cube to have closed surfaces. We then added decorative elements in the form of the abbreviations for the elements Mo for molybdenum, W for tungsten, Ta for tantalum, and N for niobium. We converted this 3D model into a layer drawing and started the print job. By the way, this component was produced from pure molybdenum powder. At an edge length of 8 x 8 x 8 centimeters, it weighs approximately 160 grams.





Customer CAD drawing



Conversion into a 3D layer model



Laser beam melts powder particles



Layer by layer, the component is produced



Finished Component



Karl-Heinz Leitz received a Best Paper Award at the 2016 Comsol Conference in Munich for his paper on the simulation of laser beam melting. The simulation expert from Plansee Innovation Services supports the process development team in enhancing and optimizing the laser melting of refractory metals. This additive manufacturing approach (3D printing) allows complex, geometrically challenging components made of molybdenum and tungsten to be produced layer by layer by melting individual layers of powder from a powder bed (see interview). Based on the simulation, analysis is being conducted on what happens on the powder scale when the individual powder particles are fused by laser, the melt spreads and covers surrounding particles, and solidifies again. These results help establish a fundamental understanding of processes that occur during refractory metal laser melting, optimize quality in the fabrication of components from molybdenum and tungsten, advance the technology, and tap new fields of application.

To supply customers better and more quickly, a growing volume of machine data at Plansee and Günther Wirth is being systematically recorded. The data is evaluated and combined with many great employee ideas to deliberately eliminate weak areas in production.



Industrie 4.0 III

Set-up time

And now, the next order please!

—— If you take a walk through Plansee High Performance Materials' manufacturing facility in Reutte, you will increasingly see machines equipped with signal lamps. Green implies that the equipment is currently running. Red indicates that the machine is out of service due to a malfunction. Blue means that it is being set up. Green and blue at the same time indicate that there is nothing to do – at least not on this machine.

—— All this information creates transparency and is the prerequisite for making production better and more efficient, not just at individual work stations, but also on entire production lines.

—— Important production data is displayed directly at the machine or via a tablet. How long was the production run? When did downtimes occur, and for what reason? Were the scheduled set-up or maintenance time frames adhered to? What were the reasons for deviations? Based on the available data, the shift supervisor discusses the past work day with the machine operator. They immediately define improvement measures that require implementation, either immediately, in the foreseeable future, or long term.

Maintenance

— Additionally, team meetings for entire production lines are held on a regular basis. Together, the employees discuss things such as: What is going well? What not so well? And what do we have to change for a better operation?

— The systematic evaluation of data, however, also brings information to light that considerably improves control of a production line as a whole. The data reveals, for instance, whether a machine poses a bottleneck

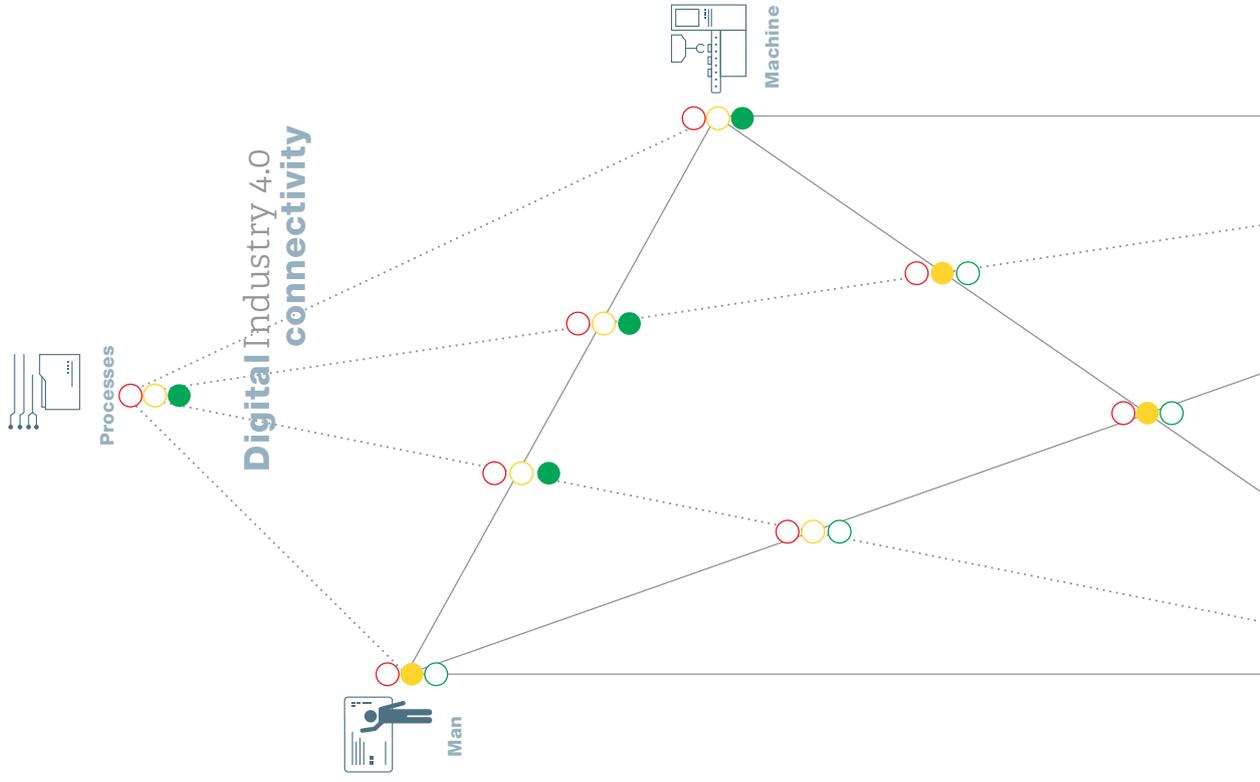
— because of its high utilization rate. In this instance, it could prove useful to purchase a second machine.

— because the machine is repeatedly experiencing malfunctions. Here, maintenance would have to be improved.

— or because material is lacking. In this case, process flows and logistics would need to be addressed to ensure that material is always available.

— Günther Wirth in Balzheim, Germany, also has ambitious goals. To offer even better service to customers, the company plans to further increase the utilization level of equipment used to manufacture solid carbide drills, and to decrease the set-up time for each order. To accomplish this, Günther Wirth is bringing data, ideas and people together. All data is carefully collected and analyzed. Regular team meetings play a crucial role in developing ideas and improving production.

Equipment downtime



The following is an interview with process engineer Johannes Reindl.

What machine data is being recorded?

We presently record the set-up time, manufacturing time, maintenance and downtimes, either for technical reasons or because material was not in place on time.

What is your objective?

We seek to reduce downtimes, boost productivity, and get the next order on the machine as quickly as possible – ultimately, what matters to us is that customers receive their product reliably and on time.

What happens to the data?

We want to analyze the data. Right now this is still being done manually, but we plan to automate the process later, with Industry 4.0 in mind. We want to make this data available to our staff so they can see for themselves where the greatest potential lies. Together with them, we then want to give some thought to implementing this improvement potential. This requires every employee on the team to be up-to-date.

Manufacturing time



Change costing

Create product template

What can employees contribute to Günther Wirth's production becoming more focused on the customer?

Indirectly, they can contribute a lot! It is important for the employees to tell us in detail about the problems and challenges they fight with every day in Production. We have improvement cards that everyone can and should fill out. Frequently, the problems are similar. So you have to ensure that material supply is sufficient, the production plan is adequate, and orders are meaningfully combined. Every day, we hold a continuous improvement meeting in each area, where we discuss the completed cards, establish focal areas, and define an action plan, so that we can gradually eliminate both everyday problems and structural challenges.

What are the next steps?

We have to take a look at the material flow in general. This will be one of the next projects – from the raw materials warehouse to the customer. By breaking down this process in more detail, we can ensure better and smarter utilization of the individual machines – and offer our customers faster delivery at competitive costs.



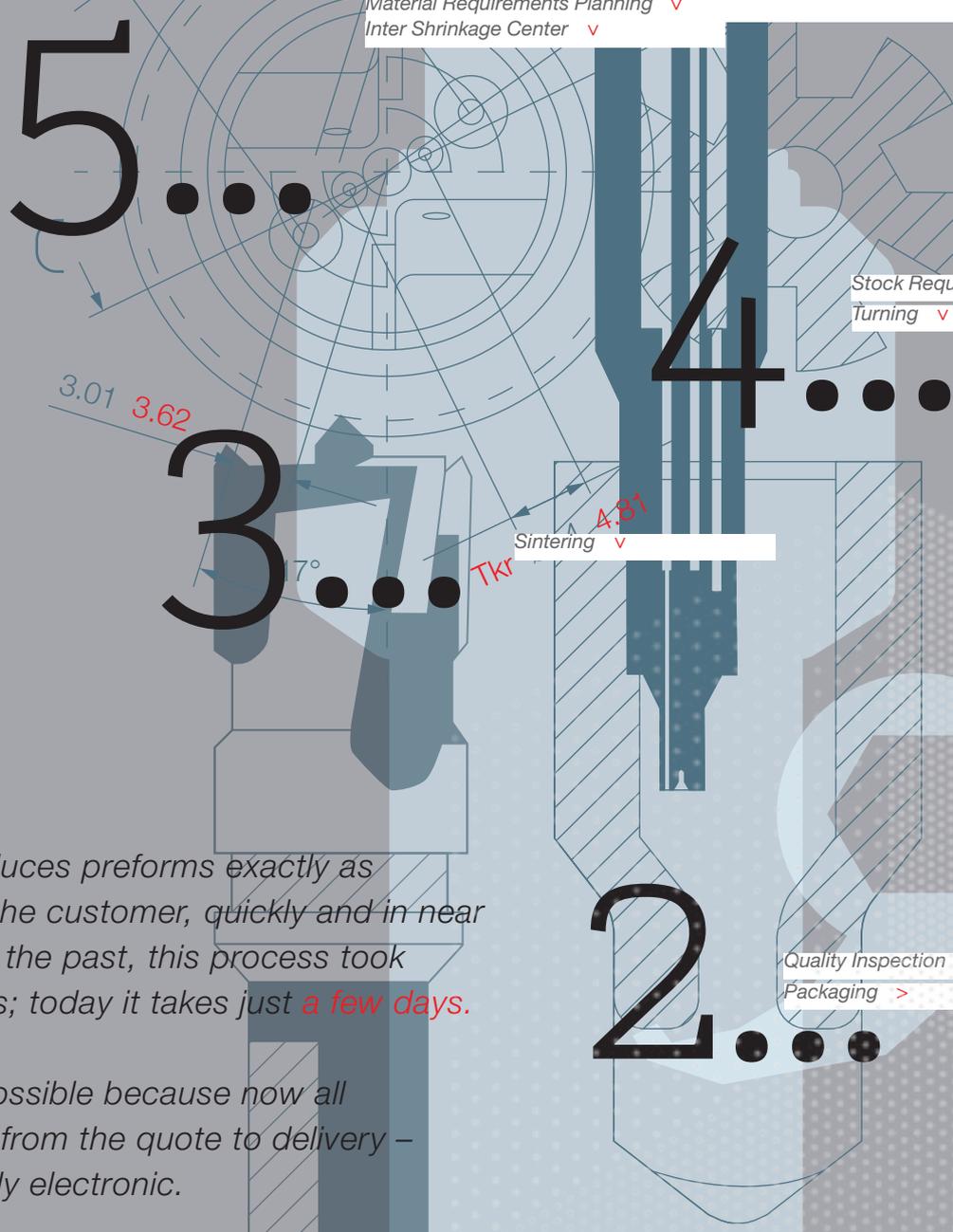
Product



Logistics

Preforms

in



Ceratzit produces preforms exactly as specified by the customer, quickly and in near net shape. In the past, this process took several weeks; today it takes just *a few days*.

This is only possible because now all work steps – from the quote to delivery – are completely electronic.

1...

Delivery >>>

DAYS

— This is how it works: Even while a Ceratizit sales support employee prepares a quote for a preform, the software checks whether the requisite material is available, whether, and especially when, production capacity is free, and in a flash computes a preliminary delivery date. Experience has shown that the faster the customer receives the quote, the greater the likelihood that the customer will in fact place an order. In this case, the software ‘piggybacks’ the data for the order and follows the order throughout Ceratizit’s entire manufacturing process – all the way to the timely shipment to the customer.

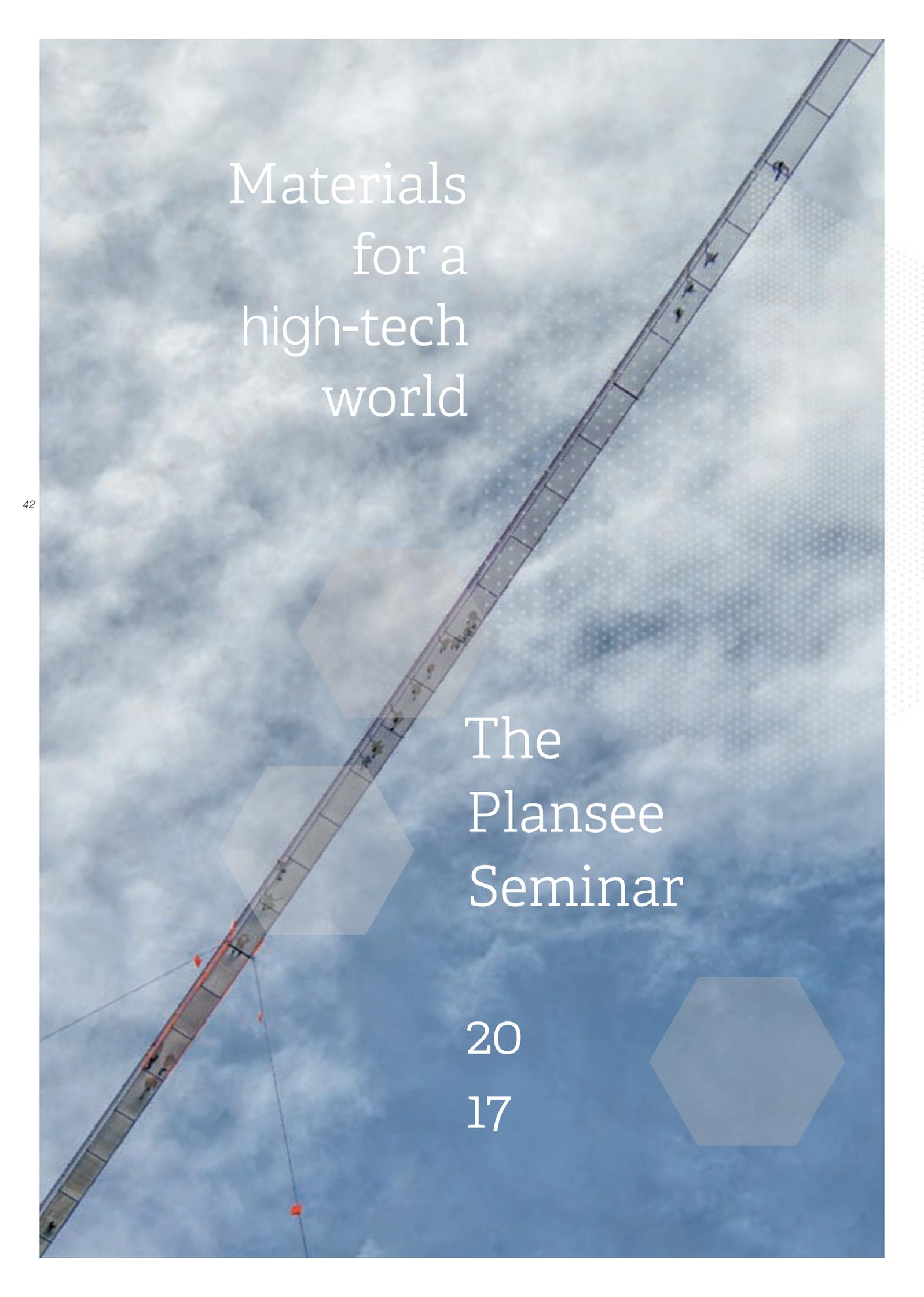
— Some preparations, however, are still necessary for production to start. Since the preforms are made to order for the particular customer, a dedicated CAD model with a drawing according to the customer’s specifications must be prepared each time. In configuring the preform, the designer at Ceratizit ensures that the grinding expense is minimized for the customer. Regular dimensional checks during and after production are necessary to meet the required quality standards. The associated inspection criteria are stored based on the CAD model.

— Then the time is right: Using advanced planning and scheduling software, the shift supervisor assigns the production orders to the machines based on urgency and suitability. The production employee receives a green light on the screen and can start the production of the preform. The employee scans the work order and opens the product drawing. In a fully automated process, the material required for the order is pulled from the warehouse. If the preform is simple to manufacture, the skilled worker creates the milling program for the blank directly at the machine. If the design of the preform is more geometrically challenging, a programmer assumes this task. This data is automatically and directly transmitted to the machine.

— The quality inspection is an entirely paperless process. Several measuring stations are installed in production, where the processed preforms are checked. The results of the caliper are wirelessly transmitted directly to the production system, and the actual and setpoint values are promptly displayed.

— To be able to ensure a non-porous structure, the preforms are sintered in a pressure furnace. All process-relevant data such as the temperature curve, pressure and atmosphere is recorded. The accompanying test specimen undergoes destructive testing and metallography and physical examinations. The data is stored in a database and made available to the customer on request.

— An end-of-line inspection is necessary since the final dimensions are not obtained until the sintering process. Here, key dimensions are checked, and the results are stored in the associated test log and linked to the production order.



Materials
for a
high-tech
world

The
Plansee
Seminar

20

17

Without molybdenum and tungsten materials, broad segments of our high-tech world would be almost inconceivable – from solar cells and LEDs, to X-ray machines, implants, displays and machining tools. In late May 2017, experts from all over the world attended the 19th Plansee Seminar in Reutte to discuss trends, new manufacturing technologies and closed-loop recycling.

«The contributions to the 2017 Plansee Seminar have demonstrated that tangible progress has been achieved in recent years in the field of refractory and hard metals, both in terms of the theoretical understanding and in the specific implementation,» said Professor Lorenz Sigl, Chairman of the Plansee Seminar and a member of the Scientific Committee.

Energy, transportation, mechanical engineering, entertainment electronics, medical technology – the list of industries dependent on powder metallurgy products based on tungsten and molybdenum is virtually endless. Most of these products are indiscernible to the user. Additionally, hard metal tools are needed for machining and shaping applications in industrial manufacturing processes or on construction sites for productivity reasons.

Regardless, these products are virtually indispensable when it comes to meeting rising quality, performance and service life demands. To ensure and enhance these attributes going forward, the scientific community is intensively working on gaining an even better understanding of the composition and manufacture of products made of molybdenum and tungsten in demanding applications.

This understanding is also necessary to advance processes such as additive manufacturing (3D printing), and to simulate product and production processes to a greater extent prior to implementing them. Additional challenges include the development of new coatings to further improve tool wear resistance and service life, as well as the systematic establishment of a closed loop for recycling valuable materials.

During the opening ceremony, guest speaker and author Michael Raynor spoke about key ingredients for successful innovations. His remarks were followed by presentations on the developments of the refractory metal markets by Ulrich Lausecker, and global trends in hard metals by Christoph Gey.

In his opening address, Karlheinz Wex, Member of the Executive Board of the Plansee Group, emphasized: «We are proud that the Plansee Seminar has been around for 65 years and remains one of the world's leading conferences on powder metallurgy. Designed as an event for materials specialists, we are delighted about the value the seminar generates for the scientific community. And in light of economic uncertainty and growing competition, I am convinced that research and development will be an essential driver in sustainably developing our business.»

This moves the

refractory metals market

While traditional applications for refractory metals are stagnating, or even on the decline, there is moderate growth in new applications.

Demand from high-temperature furnace manufacturers is brisk. Key customer groups for these furnaces are the aviation and sapphire industries.

44 In new applications, the combination of multiple material properties is becoming ever more important in selecting molybdenum, tungsten, niobium or tantalum as the material of choice.

MONDAY, 29 MAY

08:30 Musical Welcome
 09:30 Opening Ceremony
 10:00 Opening Session
 14:00 Hard Materials, Applications
 16:10 Refractory Metals Applications

Many refractory metal applications in the lighting industry have been displaced by energy-saving lamps and LEDs, to an increasing degree lately – also in automobiles.

New manufacturing technologies such as selective laser melting and other additive manufacturing processes are gaining momentum. At the same time, traditional powder metallurgical routes (pressing, sintering) continue to account for the majority of production.

TUESDAY, 30 MAY

08:30 Hard Materials 1
 8:45–17:30 *Lechtal – A challenging walk in unspoilt nature*
 10:30 Hard Materials 2
 14:00 Refractory Metals Materials 1
 14:00 Special Interest Seminar
 Hard Materials Micromechanics
 16:10 Refractory Metals Materials 2
 Hard Materials Mechanical Properties
 18:00 Poster Evening

Volatile commodity prices, which decisively determine the price of the end product, prove to be the greatest element of uncertainty.

WEDNESDAY, 31 MAY

08:30 Refractory Metals Materials 3
 8:45–17:45 *Innsbruck – Reach out and touch history beneath a spectacular mountain landscape*
 10:40 Refractory Metals, Characterization
 14:00 Hard Materials, Characterization
 16:10 Recycling and Tungsten Chemistry

Growth is also reported by the medical technology field, not only for active components such as rotating anodes, but also passive components such as shields.

Refractory metal components are needed more and more for heat management purposes in electronic applications.

This moves the
hard metals
market

Developments in the automotive and aviation industries necessitate continual increases in productivity and quality in all stages of the value chain – the tool industry can make a huge contribution in this regard.

THURSDAY, 1 JUNE

08:30 Refractory Metals Materials 3
Additive Manufacturing
08:30 Special Interest Seminar
8:45 – 17:45 Castle
Hohenschwangau- and Füssen
10:40 Refractory Metals Processing
10:50 Interest Seminar
Hard Materials PVD
14:00 Hard Materials Coating
16:10 Hard Materials, Processes
19:30 Conference Dinner

Continuous development of materials used for substrates and coatings as well as of coating processes (PVD, CVD).

Tool design providing even greater wear resistance, thus boosting further productivity and ensuring more universal use of tools.

FRIDAY, 2 JUNE

08:30 Hard Materials
10:40 Refractory Metals Simulation
12:10 Farewell Address

Tool manufacturers must establish intelligent and individualized manufacturing options to allow customers to utilize tool configurators to a greater extent. The result: fast and flexible tool production using a modular, self-organized manufacturing organization integrated in all stages of value generation.

Gaining a more profound understanding of how tools work, and how materials behave under stress, by using simulation methods.

Virtually limitless imagination.

I never
joke
about
my work.

0007

!

When James Bond appears on the big screen, his fans can count on certain things: There will be plenty of action, beautiful women, luxurious cars, an unscrupulous villain and, of course – it wouldn't be Bond without – state-of-the-art technology. How about a few examples from James Bond's history? A laser beam that can sever gold, a mini helicopter, a multi-use space ship, an electric razor with built-in display, and a ring with integrated camera.

When years, or even decades later, these technologies then become part of our everyday life, the average consumer can be certain that, in most instances, technological progress would not be possible without high-performance materials. High-tech devices, as well as the necessary manufacturing equipment, increasingly push the envelope of what is technically feasible. This requires materials such as tungsten and molybdenum, which work reliably even at their thermal, chemical or physical load limits.

»I see significant leverage to implement our goals through the development of both creative employees and creativity as a whole within the company. Inventor Day plays a very important role in these efforts.«

And it takes individuals who develop and enhance these kinds of materials for high-tech applications. »Our inventors are incredibly good, but their true achievements often go unnoticed in day-to-day business,« said Bettina Ciesla, who manages the patent department of Plansee and Ceratizit together with her husband Dirk. »To adequately recognize the performance of these employees, we organized a Plansee and Ceratizit Inventor Day for the first time this year at the Reutte and Lechbruck locations.«

Invitations to Inventor Day went out to 65 employees, who over the past two years had played a role in a patent application. They were honored with a total of 130 inventor plaques, which are stackable. Bettina Ciesla commented: »Going forward, we will make Inventor Day and the presentation of plaques a regular event. The taller the tower of plaques on the desk, the greater the inventor's productivity.« The two »greatest« inventors this year were Dr. Wolfram Knabl and Dr. Uwe Schleinkofer, each garnering five plaques. Last year, Plansee and Ceratizit filed a total of 21 patent applications, and the Plansee Group presently holds some 1500 active patents and patent applications worldwide.

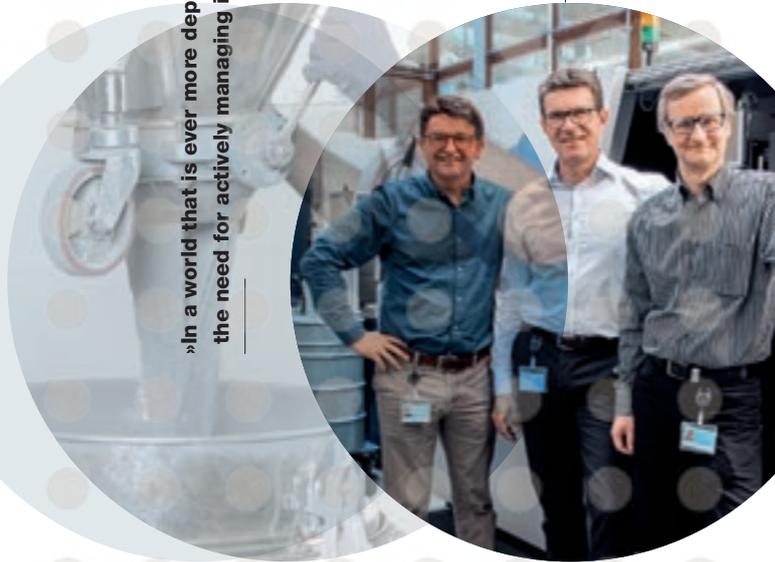
— The faces behind the many inventions, patents, and patent applications were revealed during presentation of the plaques. From innovations for refractory materials to the development of new substrates, geometries and coatings for wear-resistant tools, Plansee and Ceratizit inventors' ingenuity knows virtually no limits. A poster session highlighted practical examples on various intellectual property topics. Brief presentations provided insights into the daily work and associated challenges of some of the development departments at the Reutte and Lechbruck locations.

48 — »In a world that is ever more dependent on collaboration and cooperation, the need for actively managing inventions and patents increases as well,« Bettina Ciesla stated. She added that Inventor Day was also intended to increase awareness of the significance that patents have for the company, its customers, and the competitive environment. »Ultimately, the key is to ensure our ability to thrive as a company through active patent management,« Ciesla continued. At the same time, the company wants employees in Research & Development to know how to conduct themselves in joint projects with development partners, customers or universities to safeguard patent rights.

— Inventor Day concluded with inspiration on how to think outside the box, override old mindsets, and develop techniques to enhance creativity. Perhaps James Bond can lend a hand. In any case, the current ›Spectre‹ runs the gamut from a self-driving car to the evaluation of big data, covering many future trends that, for sure, will involve tungsten and molybdenum to some degree.

»In a world that is ever more dependent on collaboration and cooperation, the need for actively managing inventions and patents increases as well.«

Bettina Ciesla Head of IP Department



Bernhard Schretter

Member of the Executive Board of Plansee Holding AG

Innovations move our development as a business forward. Our goals include:

- legally protecting innovations
- strengthening the patent portfolio of the Plansee Group through high-quality patents
- protecting products through patents
- coping with the changed overall conditions, especially increasing competition from China, the pace of new product developments and launches, and the expansion of markets that prove challenging from an economic and/or patent perspective.

»The new product share is a key metric for us. It indicates the share that products no older than five years account for in overall sales. Our long-term objective is to increase the share of new products to at least 40 percent.«

Peter Fink Managing Director of Ceratizit Austria



Breakthrough with patented powder grades

Outstanding equipment is available in the market for anyone seeking to produce components from molybdenum and tungsten using additive manufacturing technologies. However, powders that satisfy the high requirements of the end product are very hard to come by. These applications require special powders that allow optimal production flow and offer the end user improved properties – such as high densities, excellent mechanical properties, and high dimensional accuracy. Plansee inventors Michael O’Sullivan, Heinrich Kestler and Bernhard Tabernig (photo, from left) developed powder grades that offer optimized processing and usage properties to facilitate the breakthrough of these comparatively young additive manufacturing technologies.

New milling cutter to boost revenue

Inventor Peter Burtscher: »My job was to develop a double-sided shoulder milling cutter with multiple cutting edges. I quickly had to discard the first approach since the patent situation was not very encouraging. I had no choice but to take the bull by the horns and to abandon all previous notions and think in very simple terms instead of complicating things.

One thing led to another. I mulled it over, prepared sketches and then discarded them, and suddenly I had my eureka moment: This is how it could work. And more than that: Instead of the original four cutting edges, we now even had eight cutting edges available – a revolution in the market! R&D, Production, and Tool & Die worked closely together on the prototype. New manufacturing techniques were created, ensuring efficient production. The product needed a little tweaking, but then it was obvious: It was ready to launch. Customer pilot tests with stainless steel, cast iron and aluminum delivered positive results, and sales for the new milling cutter are skyrocketing.«

Long-time favorite improved yet again

———— A coated milling grade used to machine titanium components installed, among other things, in the landing gear of airliners has been one of Ceratizit's most successful and highest revenue-producing products dating back to 2008.

———— The work of the team of developers was oriented toward further improving the milling grade by giving it an optimized coating, and thereby allowing the customer to achieve greater process stability in production. The outcome of the new development: The tool's performance has indeed improved yet again. With the new coating structure, customers are experiencing less chipping in production. What's more: the average service life is on the rise, and the cutting speed can be increased.



Peter Fink

Managing Director of Ceratizit Austria GmbH

To me, Inventor Day is inventor appreciation and a platform alike. Effective patent protection necessitates inventors who, in addition to their day-to-day business, invest a lot of time and work to translate an idea into a patent ready for filing. My greatest appreciation goes to all our employees' inventive achievements, and it is therefore important to me that Inventor Day offers them a platform which not only recognizes the ingenuity of creative employees, but also gives them the opportunity to exchange ideas and experiences and to transfer knowledge. Our inventors can only support one another in solving technical problems and challenges if they know about each other and in what areas of R&D they work.

Optimal patient care

———— The team of inventors ran just over 100 experiments over the course of three years for this enhancement, and conducted countless analyses and evaluations. The solution: They incorporated intermediate layers that significantly improve the bonding of the two previous coatings. A measuring method developed in conjunction with the University of Leoben reveals the benefits of the new coating structure. This product is by no means a random invention, but the result of a systematic, knowledge-based improvement. The Ceratizit inventors Dr. Christoph Czettl, Christian Jäger, Josef Thurner and Markus Lechleitner (from left).

———— Patients benefit from computer tomography that takes rapid images of the brain or chest yet requires only low doses of X-ray radiation, and the process can be used routinely and for early detection. It allows physicians to make a faster and better-informed decision on individual treatment.

———— Plansee makes a crucial contribution through its ongoing development of X-ray rotating anodes, which are a heavily used key component in computer tomographs. On their surface, they absorb heat that develops during generation of the X-rays.

———— The goal of the development was to allow the rotating anode to absorb greater amounts of heat within shorter periods. Previously, no rotating anode was able to accomplish this feat, and so a new manufacturing process was developed to establish the necessary properties. Plansee inventors Jürgen Schatte, Wolfram Knabl, Stefan Schönauer, Wolfgang Glatz (from left) and Johann Eiter (not pictured) achieved patent protection for this new development.



TIKOMET HOITAA ROMUSSI*

** Let T!komet take care of your scrap!*



Tikomet is specialized in recycling hard metal scrap back into hard metal powder. For this purpose, the company is constantly looking for new sources of scrap to expand its businesses.

53

———— Tikomet has been a member of Global Tungsten & Powders since 2015 and is a hard metal recycling expert. Equipped with state-of-the-art technology, the facility in Jyväskylä, Finland processes hard metal scrap into tungsten carbide powder using the zinc process – an important contribution to the creation of closed production cycles and conservation of resources.

Raw material for tire studs

———— Tikomet Oy was founded in Tikkakoski in 1994. Since the 1960s, the company's predecessors have manufactured tire studs used in Nordic winter tires to deal with ice and snow. Initially, Tikomet predominantly produced recycled hard metal powder as the raw material for hard metal pins for tire studs. Until 2007, this was the primary sales market. The construction of a new plant showcasing state-of-the-art technology prompted the development of new markets. Thanks to new technology, the zinc process has allowed tungsten carbide powders to achieve a new standard of quality.

Proprietary furnaces

———— Tikomet evolved into one of Europe's leading zinc recyclers in no time. The company developed and built key pieces of production equipment in-house. A team of developers is continually working on advancing the zinc process, and the product quality undergoes routine testing in a dedicated hard metal lab. Tikomet's development efforts additionally focus on application engineering where zinc reclaim powder is blended with virgin raw materials. These hard metal batches are then scrutinized for their processing and performance characteristics.



Valuable materials

«We expect tungsten scrap recycling to play an increasingly important role going forward,» Tikomet's Managing Director Teemu Liukkonen is convinced. He finds it difficult, though, to refer to the valuable material his company processes as ›scrap‹. The reasons are obvious: Recycling is an essential part in the conservation of resources, reduces the environmental impact, saves energy and plays an important role in supplying the hard metal industry with raw materials.

Quality in = quality out

The zinc process is equally suited for recycling sorted scrap incurred in hard metal manufacturers' operations and clean, well-sorted end-of-life hard metal tools. »The quality of the scrap we use in the zinc process essentially determines the quality of the powder,« says Teemu Liukkonen. This makes high-quality and correctly sorted scrap a crucial ingredient for a good end product. Tikomet purchases high-grade hard metal scrap from across the globe.

Tikomet offers the following products and services:

- Tikomet purchases high-grade hard metal scrap and recycles it into reclaim powder by the zinc process.
- Conversion service by customer request: For customers that provide high-grade scrap, either their own or from their customers, Tikomet processes the material into custom powders by the zinc process.
- Ready-to-press powders.

Distinction between chemistry and physics

———— There are two key processes for hard metal scrap recycling: the chemical process, in which scrap goes through the same process as powders from tungsten ore mining, and the zinc process, in which scrap is processed directly into a tungsten carbide-cobalt alloy powder without using chemicals. Hard metal scrap is heated in a special furnace together with zinc metal, causing the cobalt binder to react with the molten zinc. Inter-metallic compounds form, and the reaction prompts a volume expansion. The scrap swells and breaks up into a porous cake made of tungsten carbide and cobalt. The zinc is evaporated at high temperatures and recovered.

———— The porous cake is milled into powder, ground and homogenized.

———— In contrast to chemical processing, the original grain size of the hard metal does not change. Additionally, cubic carbides such as tantalum carbide, titanium carbide and niobium carbide are retained. The fact that the zinc process is a physical/mechanical method with no chemical modification means that clean and well-sorted scrap is required to ensure reclaimed powder of high quality.

Compelling arguments

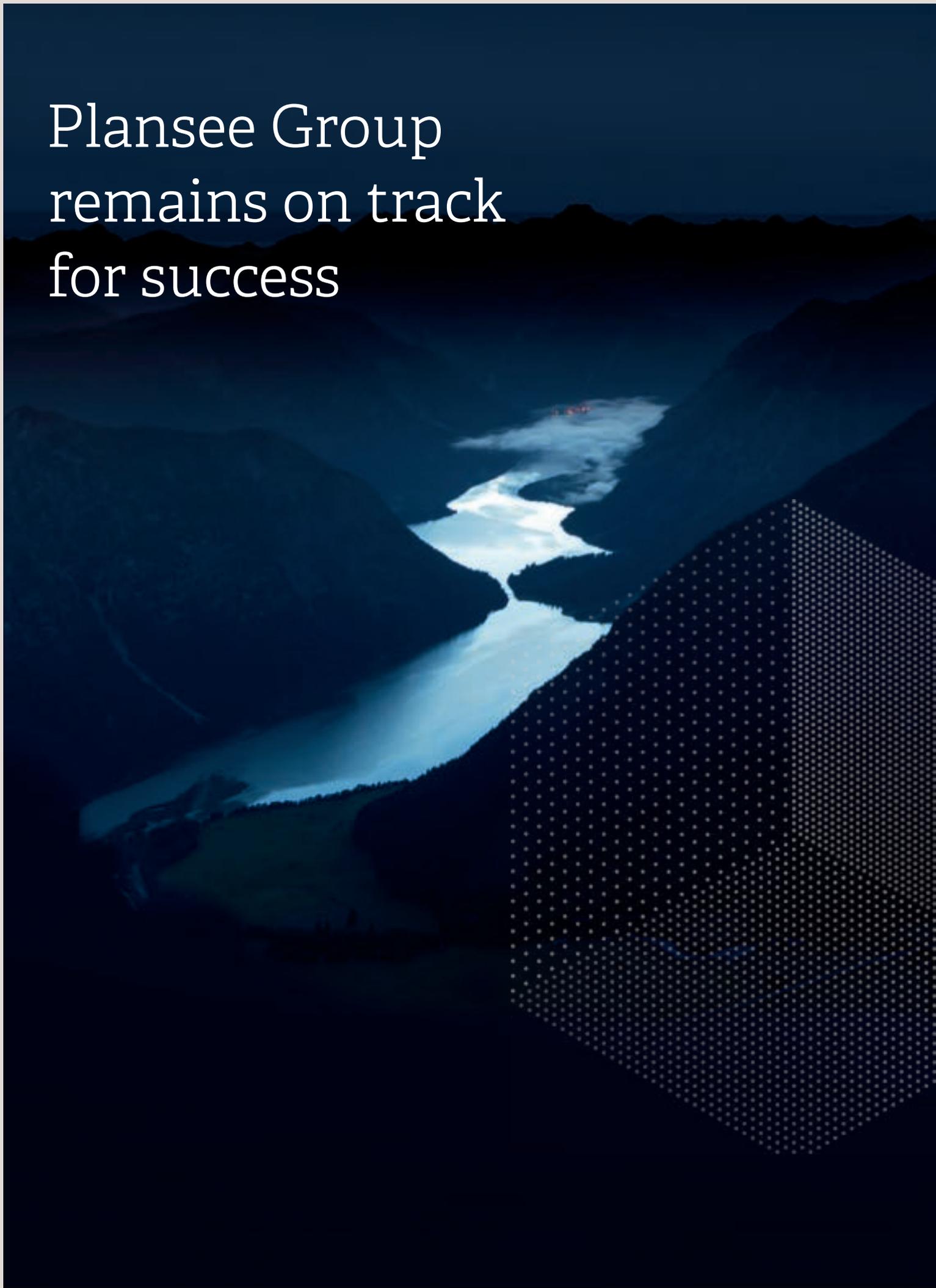
———— In comparison with the chemical methods, advantages of the zinc process include its environmentally friendly technology, reduced energy consumption and lower CO₂ emissions compared with the processing of raw materials from mining operations. Zinc reclaim powders are used in the production of indexable inserts for cutting tools and for the pins for tire studs. In recent years, hard metal manufacturers have developed new applications as the quality of the reclaim powder has improved. Applications now include solid carbide tools such as drills and milling cutters, hot rolling rolls, mining compacts, wear parts, woodworking tools, and thermal spray powders.

———— Using reclaim powders in tools that have high raw material cost in relation to selling price is a particularly interesting application.



tungsten-scrap.eu

Plansee Group remains on track for success



In the 2016/17 fiscal year, which ended on 28 February 2017, the Plansee Group achieved consolidated sales of 1.17 billion euros.

Increased volume and market share

«Despite further declining raw materials prices, we have managed to stabilize sales at the same level as last year,» said Plansee Group Chairman of the Executive Board Dr. Michael Schwarzkopf at the press conference held in Reutte to present the company's financial results. Sales volumes and market share showed continued growth in all regions. The Group benefited from the strength of the German export industry, above all the automotive and mechanical engineering industries. There was also growth in the aerospace industry and in the field of alternative power generation (fuel cells).

Following the launch of the long-term fitness program ›Marathon‹ across the group two years ago, all Group companies have further improved their competitiveness. »Ongoing optimization, cost management and organizational adjustments have enabled us to significantly improve our business processes and operating result«, Schwarzkopf was pleased to report.

Continued global expansion

Over the past fiscal year, the Plansee Group has continued to systematically internationalize its activities. A total of 180 million euros was invested globally. Highlights included construction of a new production and sales site in Korea, site expansions in India, China and Germany, and the acquisition of the tool manufacturers Best Carbide in the USA and Becker Diamantwerkzeuge in Germany. Both companies were acquired by the joint venture Ceratizit, in which the Group has a 50 percent holding. »Especially in Ceratizit's carbide and tool business, we still see potential for acquisitions to boost growth beyond the levels already achieved by strong, organic growth,« Schwarzkopf explains.

New products make up 33 percent of sales

As in previous years, the Plansee Group invested more than 60 million euros (5 percent of sales) in the development of new products and in improved processes. The share of sales with new products (products less than 5 years old) remains above 30 percent. »Innovative products made from our metals tungsten and molybdenum for new applications in high-tech industries are the key to us continuing to be an attractive partner for our customers,« Schwarzkopf stressed.

First digital business model due to be implemented

Furthermore, last year saw the launch of a large number of initiatives in the area of Industry 4.0. The first digital business model is expected to be ready for the market launch in the current 2017/18 fiscal year.

The industry portfolio

The Plansee Group has constantly expanded its industry portfolio over the past ten years. Taken together, all companies in which the Group has a holding achieved sales of 2.14 billion euros in the 2016/17 fiscal year. Production sales at Breitenwang/Reutte reached 570 million euros. All Group companies have a global workforce of 12,000.

»In the mid-nineties, we realized only 50 percent of our sales from activities where we ranked among the top three players worldwide. Today it is significantly more than 90 percent.«

Michael Schwarzkopf *Vorsitzender des Aufsichtsrats der Plansee Holding AG*

Michael Schwarzkopf moves to Supervisory Board

After the annual press conference, Dr. Michael Schwarzkopf announced that he will move to the Supervisory Board. His former colleagues on the Executive Board, Bernhard Schretter and Karlheinz Wex, are leading the Plansee Group since 7 July 2017.

Schwarzkopf worked for 27 years with operational responsibility for the Plansee Group and for 21 years he was Chairman of the Executive Board. »After my withdrawal from day-to-day business, I will, as an active Chairman of the Supervisory Board, focus primarily on two topics – the strategic development of the Plansee Group and the continuous development of top management,« Schwarzkopf said.

Karlheinz Wex emphasized the importance of financial independence as a success factor, coupled with the need to continue the sustainable profitable growth of the Plansee Group. Bernhard Schretter pointed out the responsibility of the Plansee Group as an employer in the Außerfern region. Both Schretter and Wex emphasized the need for continuous improvement in order to be competitive in the global markets. Thanks to digitalization and ›Industry 4.0‹, they see big differentiation potential for the Plansee Group.

Schwarzkopf joined the Plansee Group in 1990. He led the Mexican subsidiary Sintermex from 1991 to 1993, became a member of the Executive Board in 1993 and Chairman of the Executive Board of the Plansee Group in 1996. Over the past 21 years, the Group has developed into one of the world's leading companies specialized in the high-tech materials molybdenum and tungsten. In this area, the Plansee Group now covers the entire value-added chain, from the powder through to the customer-specific component.

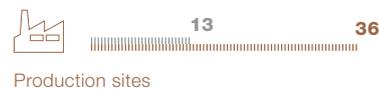
Schwarzkopf described the portfolio-related measures taken to achieve today's world market position as the most important strategic steps during his time as Chairman of the Executive Board. These include the hard metal joint venture Ceratizit, the takeover of the tungsten powder specialist GTP and the investment in the Chilean molybdenum ore processing company Molymet, as well as the disinvestment of the automotive supplier PMG.

The Plansee Group has benefited from the strategic positioning and rapidly accelerating globalization of the past 15 years. In 1996, sales of the industrial portfolio were 300 million euros, of which 80 per cent were realized in Europe. In the past fiscal year, this figure was 2.14 billion euros, of which 50 per cent were realized outside Europe. »And we are winning market share year after year, and this is crucial,« said Schwarzkopf.

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Success story:

1996 — 2006



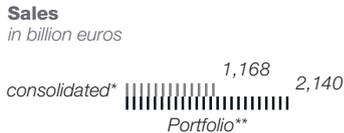
Expatriates worldwide
 44 employees



Internal recruitment
 of management positions

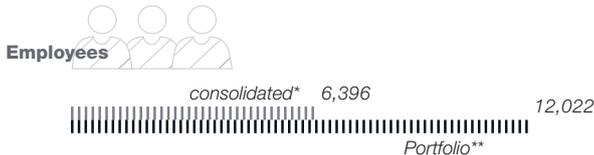


Share of recycled tungsten
 used in the Plansee Group
 >50%



Investments
 ... thereof Research & Development
 60 million euros

180 million euros

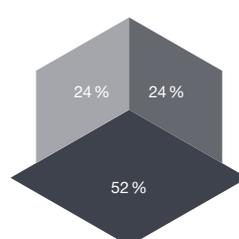
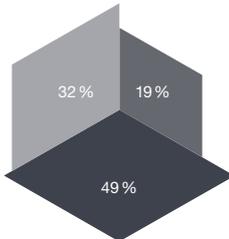
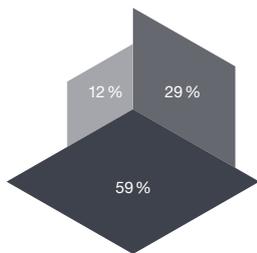


Sales by region

2006/2007

2011/2012

2016/2017



■ Europe ■ Asia ■ Americas

*Consolidated figures of the Plansee Group

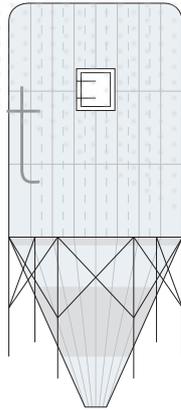
**All associated companies, where the Plansee Group holds more than 20 percent of the shares

Investment I:

We

grow

14t

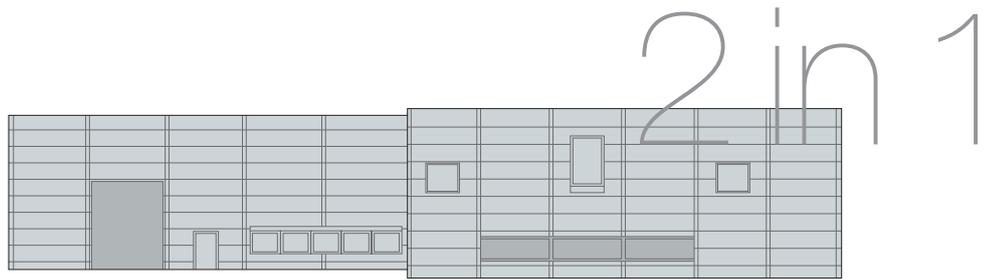


Powder preparation expanded

Reutte — In August 2017, the new powder preparation facility in Reutte commenced operations, marking another step in the effort to secure Ceratizit's supply of ready-to-press hard metal grade powder in the long term. The powder preparation operation produces ready-to-press hard metal granules by first mixing the starting materials with water in agitator ball mills and grinding them. Then, the hard metal suspension is sprayed in a counter-current process using hot air based on the fountain principle, generating the desired granules. The new spray tower has a diameter of 5.40 meters (17.7 feet), is 12.50 meters (41 feet) tall and weighs 14 tons.



Successful expansion

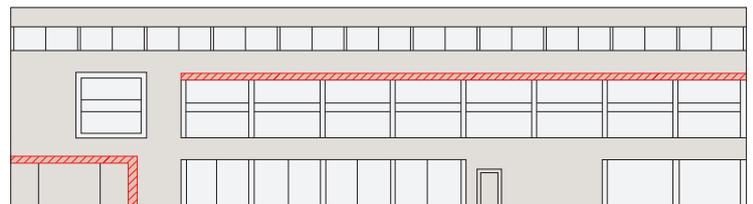


Balzheim — The production capacity for solid carbide drills and milling cutters has been stepped up yet again. In light of brisk market demand, Ceratizit has dramatically expanded the Balzheim site, where the two manufacturing subsidiaries Günther Wirth and Klenk are located.

Production line realigned



Mamer — How can we produce in the best and fastest way possible? This was the guiding principle behind the reorganization of the cutting inserts production line at Ceratizit's Mamer site in Luxembourg. In addition to the production line encompassing 41 presses and eight furnaces, the new building is also home to the Research & Development and Engineering departments as well as a fully-equipped R&D lab and a restaurant for all employees.



Automated production

Reutte — The plant is seeking to lower production costs, minimize equipment downtime and reduce scrap, while producing top-notch rotating anodes, which are a high-tech product and key component in computer tomographs. In the new building accommodating the rotating anode manufacturing operation in Reutte, an automated, digitized production line will be established that is ready for the requirements of Industry 4.0. Intelligent interfaces and consistent product coding are intended to ensure that all order- and product-specific data can be digitally retrieved and tracked in real time at any given moment. This will allow the plant to systematically record production-relevant process data, and to identify and implement needed optimizations as well as concurrent quality assurance more quickly and efficiently. The project was officially launched in March 2017 in the presence of Austria's Chancellor Christian Kern.



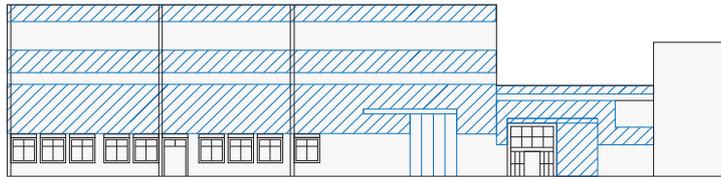
New plant opening

Seoul — Plansee has taken up residence with a new plant in close proximity to its customers, serving as a supplier to major display and semiconductor manufacturers in Korea. The plant prepares coating materials (sputtering targets) for use in the customers' coating facilities.

Opening of WNT China

Shanghai — The catalog for China with which WNT entered the market in October 2016 contains 15,000 machining tools. All listed tools can be shipped from the warehouse in Shanghai. This marks the continued expansion of tool merchant WNT, which supplies the Asian market with quality tools and WNT's unrivaled service from the Shanghai location. »The Chinese market is growing rapidly and is becoming more and more discerning and quality-conscious. This requires good technical support. With its strong team, WNT is able to fully satisfy these requirements,« said WNT managing director Claude Sun during the opening ceremony of the new WNT branch in Shanghai on November 18. He added: »WNT's service concept is very successful in Europe, and we are convinced that we will also be able to live up to customer's expectations in China.«

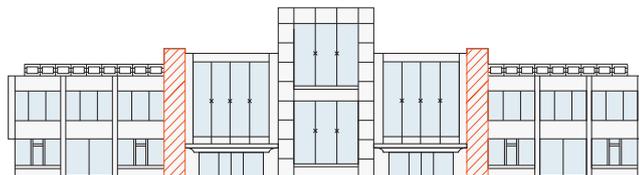
15,000



New home of Ceratizit India

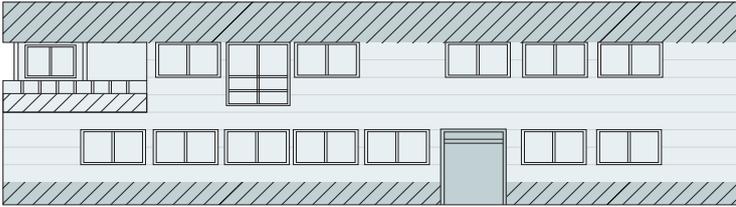
Uluberia — Ceratizit is expanding its presence as a provider of quality hard metal tools in India. The most visible sign is the relocation into the new state-of-the-art plant in Uluberia outside the gates of Kolkata. The facility combines production, the warehouse, logistics and offices under one roof. Not long after its opening, the new plant was recognized by India's government as one of the best manufacturing sites in West Bengal. The new location is equipped with modern machinery, has well-organized material flows, and offers employees a cafeteria and a fitness center.

4 in 1



Investment II:

Mergers & Acquisitions



From blank to solid carbide tool

———— Ceratizit aims to grow in the solid carbide tool market, both organically and through acquisitions. Since 2012, Ceratizit has already acquired five companies in the USA, Germany and India in this product segment.

———— The most recent acquisitions include Germany's Becker Diamantwerkzeuge in December 2016, and US tool manufacturer Best Carbide in January 2017.

———— Having previously only operated as a hard metal rod supplier and a dealer in this market, Ceratizit has established a strong market position for solid carbide tools over the course of five years as a result of these acquisitions. Drills, milling cutters and reamers made of solid carbide are produced from what are known as rod blanks. These blanks are shaped according to the customer's drawing in modern complete machining centers. Solid carbide tools are used wherever maximum productivity is key in machining, or where materials that are difficult to machine are used.

———— »Our analysis has shown that the market for solid carbide tools offers attractive growth opportunities in the medium term, most notably in the USA and Asia, and that this market has not experienced the same strong consolidation as the market for cutting insert tools,« said John O'Hara, member of Ceratizit's Executive Board.

———— Following the acquisitions, Ceratizit has also stepped up the pace on its organic growth. Over the past five years, for example, the company has made higher-than-average investments in expanding the capacities of its existing manufacturing locations.

Becker Diamantwerkzeuge

———— Becker Diamantwerkzeuge produces extremely wear-resistant tools for the automotive, mechanical engineering, medical technology, and aerospace industries. Becker tools are a sought-after product for exotic materials that are difficult to machine, such as aluminum, carbon fiber-reinforced polymers or high-alloy steel. To minimize wear during machining, the cutting edges of hard metal tools are reinforced with diamond or boron nitride. Becker Diamantwerkzeuge has more than 70 employees.

Best Carbide

———— Privately held Best Carbide is a manufacturer of solid carbide tools located in Rancho Dominguez, California, and has more than 100 employees. The company is known for the high quality of its micro tools and ideally complements Ceratizit's portfolio. Applications for the hard metal drills and milling cutters include the aerospace, medical technology and mechanical engineering industries.

Roasted molybdenum concentrate refinement process

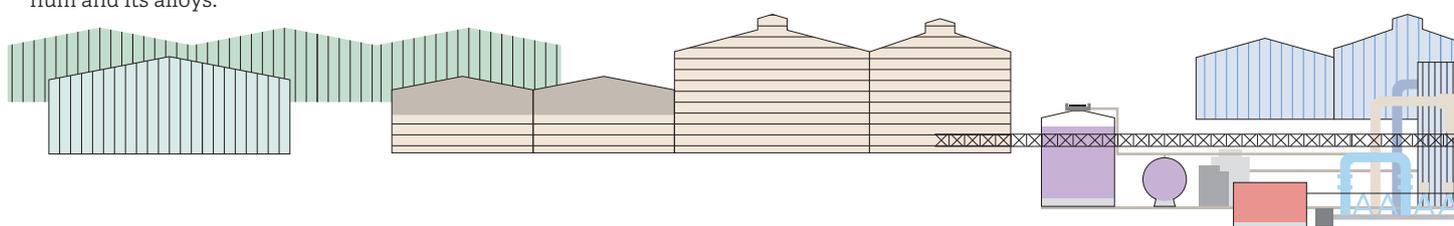
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———— Molymet is investing 40 million euros in a new plant to produce high-purity molybdenum oxide. The facility will be built at its subsidiary Sadaci in Ghent, Belgium.

———— High-purity molybdenum oxide is needed predominantly by the refractory metal-processing industry, where it is reduced to molybdenum metal powder before being further processed into semi-finished products and components made of molybdenum and its alloys.

———— The new factory, along with the capability to process high-quality molybdenum concentrates, will allow the Sadaci plant to significantly expand its product range.

———— The highly automated facility will operate around the clock and be staffed by 34 employees. Particular care was given to ensure a minimal carbon footprint of the facility.



———— With the construction project, the Sadaci plant is taking another crucial step toward the goal of manufacturing and marketing premium molybdenum products.

———— Construction started in mid-2017, and the plant is scheduled to be commissioned in the first half of 2019. The new facility will complement the existing production operation in Ghent. The location is already home to the world's largest roaster for molybdenum concentrates, a sulfuric acid production plant, as well as Europe's largest facility producing ferromolybdenum (FeMo) for the steel industry.

———— The new plant will allow the Molymet Group to further improve guaranteed delivery and considerably cut delivery times to its European customers. Molymet can then focus on strengthening existing customer relationships and support the continued growth and development of its customers.

Good to know

Molymet roasts (oxidizes) molybdenum concentrate (RMC) to produce technical molybdenum oxide (TMO), which serves as the feedstock for the new production process developed for Sadaci in Ghent. This material undergoes several chemical purification steps, resulting in an ammonium dimolybdate (ADM) solution, which is then crystallized. ADM is broken down into pure molybdenum trioxide (PMO), which has a purity of at least 99.98 percent, is chemically homogeneous, and stands out with a particularly uniform particle size distribution.

40

FeMo



34



As a professional UCI team, the WNT Pro Cycling team now participates in a large number of international races representing WNT and increasing awareness of the company among a broader audience.

The plan is paying off

Three years ago, metal cutting expert WNT established a women's cycling team in England. It was an experiment that started on a small, regional scale and has since evolved into an important part of WNT's marketing mix. An interview with WNT Managing Director Claude Sun.

When was the idea to combine WNT's values with cycling conceived?

We took part in a three-day charity race from London to Paris. To our amazement, 80 employees from 8 WNT branches participated, all of them regular recreational athletes. I realized that the bike would be a good way to bring the company's values to life, having undergone continual, steady growth all across Europe in recent years.

5 cyclists from 5 nations – England, Ireland, Austria, Luxembourg, Scotland

You started with a 3-member women's cycling team in England – how did this come about?

The UK was an obvious choice since women's cycling is widely accepted there and is experiencing an incredible boom. We wanted to take advantage of this to become firmly established. While most cyclists come from the UK, 5 nations are now represented on the WNT Pro Cycling team. We plan to expand the team's global nature in the future.

What makes it worthwhile to invest in cycling?

Aside from the UK, cycling is also gaining in popularity again in other European countries. In Germany, too, the cycling scene is very active again. At present, we are positioning ourselves. When cycling races are broadcast live on television in other countries, we are part of it. That's when the investment really pays off.



In what respect?

The more name recognition a company has in its target group, the more sales it can generate. As a result of *WNT sponsors 11 races. Customers are invited to these races.* the continuously growing media presence we achieve through our sponsorship, the WNT brand is gaining in popularity among the general public. Ultimately, this will have a positive impact on the sales figures. At the same time, continuity is very important. Increasing the company's name recognition won't happen within a year; this will take longer-term investments, and the concept must be developed gradually. We started three years ago with a very limited budget and a small team. Over time, we have been able to continue to expand the team together with our customers Hope Technologie and Rotor Bike Components. As a professional team, we are now able to attract attention throughout Europe and increase awareness of the WNT brand.

What is your conclusion from being a cycling sponsor?

Cycling sponsorship is paying off for us in many respects. Promoting bikes as a high-tech product, we can establish a connection to our precision tools and increase customer awareness of us as a metal cutting specialist across Europe. We also use cycling as a way to enhance customer loyalty, since the WNT Pro Cycling team is invited to customer events. For our customers, it's a terrific experience to ride alongside a professional team. The WNT team also kind of serves as an example for our employees and symbolizes our corporate values.

42 races are held throughout Europe and the World Championships in Hong Kong.

In short:
it works – the plan is paying off!

» **Cycling sponsoring is paying off for us in many respects. Promoting bikes as a high-tech product, we can establish a connection to our precision tools and increase customer awareness of us as a metal cutting specialist across Europe.**

«
Claude Sun
WNT Managing Director

All Plansee Group divisions achieve excellence along the whole value chain of molybdenum and tungsten production, and have proven expertise in materials, technologies and applications.

Our markets



Our mission

Our growth markets

Mobility & Transportation

- Spray wire for friction-reducing coatings for gears and other moving parts
- Components for H4 and xenon lamps
- Tungsten fine wire for automotive lamps and heating front and rear windshields
- Counterweights for crankshafts
- Tools for machining engine blocks, crankshafts, aluminum wheels and brake discs
- Tungsten and molybdenum based Thermal Spray Powders for corrosion- and wear-resistant coatings

Consumer electronics

- Plant components for producing LEDs and semiconductors
- Components for the production of sapphire glass (camera lenses, glass cover, carrier plates for LEDs)
- Base plates for semiconductors
- Coating materials for displays

Medical technology

- Hard metal components for dental instruments and the whole medical industry
- Components which generate, direct and shield radiation for use in X-ray machines and oncological irradiation devices

Mechanical engineering

- Heater elements for high-temperature and vacuum furnaces
- Temperature-resistant components for coating plants
- Coating materials for tools
- Nozzles for plastic injection molding
- Electrodes, tank cladding and stirrers for glass manufacture
- Shearing blades, cutting wheels and lens tools for the glass industry
- Tools for shaping and processing
- High-performance tools made from hard metals using cutting inserts
- Tools for diamond production

Construction industry

- Tools for wood and stone working
- Drilling and milling tools for tunnel boring
- Milling tools for road building
- Hard metal compacts for the agriculture industry (ploughs and blades)
- Forming tools for producing nails, rivets and screws

Power engineering

- Powder blends for manufacturing drills in oil and gas exploration
- Coating materials for solar cells
- Electrical contacts for medium and high voltage
- Electrically and thermally conductive components for solid oxide fuel cells
- Thread cutters for machining drill rods and borehole tubing
- Carbide contacts for drill heads
- Tools for producing gas turbines
- Tools for machining pipelines

Semiconductor industry

- Components and spare parts for ion implantation
- Heat sinks and heat spreaders for semiconductors
- Tiny drills for the processing of PCBs Components for manufacturing semiconductor layers (MOCVD)
- Wires for tantalum capacitors
- Baseplates for power electronics

Aerospace industry

- Gold-plated wires for satellite technology
- Cutting tools for machining integral components
- High-performance tools for processing titanium and superalloys
- Tools for machining airplane turbines
- Billets for die tools to forge turbines

We develop, produce and market products that are based on the high-technology materials molybdenum and tungsten.

— Since 95 years, we have produced powder metallurgical products that stand out in terms of their quality and availability – products that have enabled our customers to increase productivity and make major technological advances.

Our production technologies cover every step of the value chain.

— It is our customers who determine how much internal added-value our products bring – whether it be powder, semi-finished or ready-to-use components. To ensure we remain the preferred partner to our customers, we continuously invest in training for our employees, in the latest technology, and in increasing our production capacity – from powder production through powder metallurgical processes to the customer-specific processing and recycling of our materials.

We tailor our customer services, development and production to suit the requirements of our markets.

— The market defines what properties are required of our products. In order to best serve our different markets, we group our activities into business units. This ensures that we can achieve strong working relationships with all of our customers, while offering them made-to-measure product solutions. We continue this focused customer relationship management during the development and production stages.

Our targets

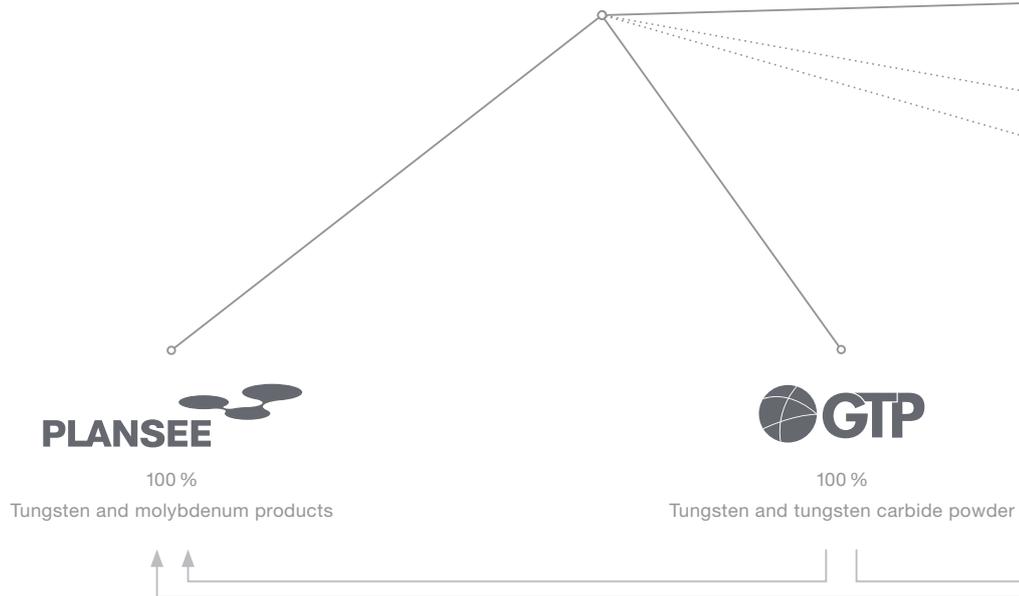
— The Plansee Group aims to be the world's leading and preferred supplier of the high-technology materials molybdenum and tungsten along the whole value chain.

The following Group objectives are valid for all divisions:

- Our business activities have market-leading positions worldwide.
- Our companies outperform the market. They are clearly positioned, profitable over the long-term, and achieve ambitious financial targets.
- The Group is an employer of choice throughout the world.

PLANSEE

The Plansee Group



Plansee High Performance Materials: strong metals

Whether in screens for TVs, smartphones or tablets, energy-saving LEDs or environmentally friendly fuel cells, the refractory metals tungsten, molybdenum, tantalum, niobium and chromium come to the fore where traditional materials have reached their limits.

Tungsten, tantalum and molybdenum are the most heat-resistant materials available, apart from carbon. With their high melting points they are perfect for use as heater elements in high-temperature furnaces and as crucibles for sapphire production. Their excellent electrical and thermal conductivity makes them ideally suited to use in electrical switch contacts. And they are used as electrically conductive layers in flat screens and solar cells. They have many additional properties which are in demand, such as high density and purity, high wear and corrosion resistance and are also capable of absorbing radiation.

The Plansee High Performance Materials (HPM) division manufactures refractory metals and composites from metal powders. Plansee is involved in the process right from the start: GTP and Molymet process ore concentrates from mines into metal oxides, which Plansee then reduces to pure metal powder. The metal powder is then compacted, sintered and processed in various additional forming steps to produce highly resistant materials and products.

Plansee HPM operates in the following markets: the coating industry, energy transmission and distribution, the lighting industry, thermal processes, ion implantation, the electronics industry, tungsten-heavy metal alloys, medical technology and sapphire production.

GTP – Powders That Shape Your World

The US company Global Tungsten & Powders (GTP) is one of the largest processors of tungsten ore concentrates and secondary raw material (SRM) in the Western world. Ore concentrates and SRM are first converted to ammonium paratungstate (APT) and then processed further into tungsten metal, tungsten carbide and ready-to-press powders.

GTP strongly believes that tungsten, a critical raw material used in many important downstream industries, requires a balanced supply chain between the Western world and China where 85 % of the global reserves are located. GTP recently became a shareholder in a mine / concentrate producer, further securing a western-based, conflict-free supply chain that all our customers can rely on. Over the past 20 years, GTP has grown from a US-based company to a true global player. With production and sales locations throughout the world, GTP can respond quickly to customer needs everywhere.

Together with the subsidiary Tikomet, GTP has the broadest recycling competence in the tungsten industry. Whether chemical recycling, converting via the zinc process or converting on behalf of the customer – GTP supports its customers in the implementation of closed material cycles.

Plansee Group Service GmbH

Plansee Group Service GmbH is a service provider within the Plansee Group. It develops standards and guidelines for corporate activities and delivers central services. Plansee Group Services presently offers the following services: IT app development and IT services, Controlling, finance and accounting, cash pool, legal matters, patents, export compliance, corporate development and M&A, IT and corporate security, HR organization and development, and communication.



50 %

Tungsten carbide products



20.7 %

Molybdenum metal powder

Ceratzit – Tooling the Future

For over 95 years, Ceratzit has been a pioneer developing exceptional hard material products for cutting tools and wear protection. The privately owned company, based in Mamer, Luxembourg, develops and manufactures highly specialised carbide cutting tools, inserts and rods made of hard materials as well as wear parts. The Ceratzit Group is the market leader in several wear part application areas, and successfully develops new types of carbide, cermet and ceramic grades which are used for instance in the wood and stone working industry.

With over 6,000 employees at 27 production sites and a sales network of over 60 branch offices, Ceratzit is a global player in the carbide industry. As a leader in materials technology, Ceratzit continuously invests in research and development and holds over 600 patents. Innovative carbide solutions from Ceratzit are used in mechanical engineering and tool construction and many other industries including the automotive, aerospace, oil and medical sectors.

The internationally active Ceratzit Group unites the four competence brands Cutting Solutions by Ceratzit, Hard Material Solutions by Ceratzit, Tool Solutions by Ceratzit and Toolmaker Solutions by Ceratzit. The carbide expert also includes the subsidiaries WNT and CB-Ceratzit, as well as the tool manufacturers Günther Wirth, Promax Tools, Klenk, Cobra Carbide India, Becker Diamantwerkzeuge and Best Carbide Cutting Tools.

Molymet – the world's largest processor of molybdenum

The Chilean company Molymet is the world's largest processor of molybdenum ore concentrates and rhenium. Molybdenum is an alloying element for increasing strength, corrosion and heat resistance, especially in steel alloys. The petrochemical industry uses molybdenum as a catalyst for removing sulfur. Plansee HPM's molybdenum finished products are based on commercial-grade and pure molybdenum oxides.

Established in 1975, Molymet first debuted on the Santiago stock exchange in 1983.

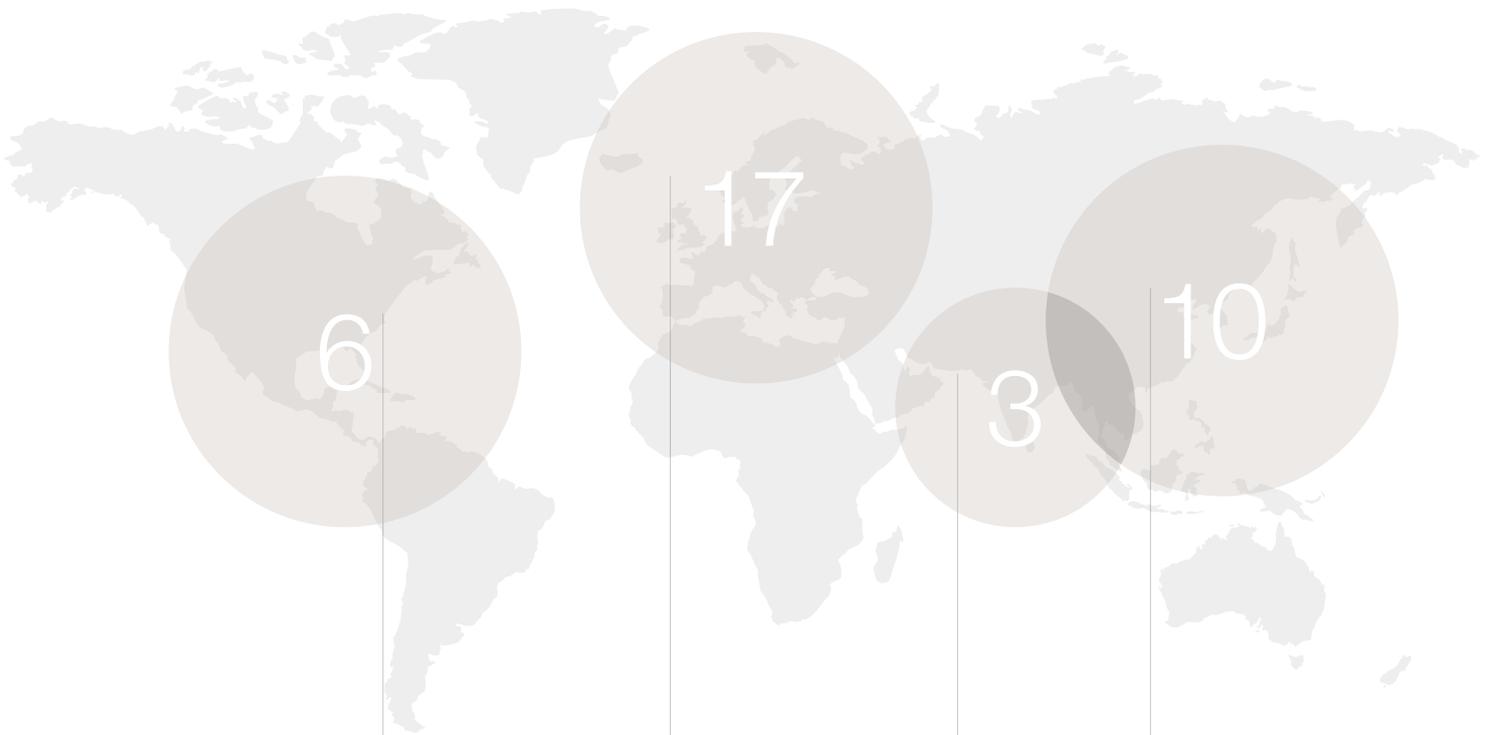
Molymet has long been one of the Plansee Group's key suppliers. With a 20 percent share in Molymet, the Plansee Group is the company's largest shareholder, helping to secure its supply of the raw material molybdenum.

The company employs roughly 1,750 people at six sites around the world.

36 production sites

Sales offices and representatives in over 50 countries

72



6

Franklin
Rancho Cordova
Rancho Dominguez
Towanda
Vista
Warren

17

Alserio
Balzheim
Bruntál
Creutzwald
Empfingen
Gabrovo
Hitzacker
Jyväskylä
Landsberg
Lechbruck
Livange
Liezen
Mamer
Niederkorn
Seon
Saint-Pierre-en-Faucigny
Reutte

3

Bangalore
Mysore
Uluberia

10

Esashi
Sakura
Seoul
Shanghai (2x)
Tamsui
Tianjin
Wugu
Xiamen
Zhangzhou

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Mag. Karlheinz Wex

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Translation

Maintal Translations, Inc.,
Virginia Beach, VA, USA

Concept & Design

jäger & jäger, Überlingen
jaegerundjaeger.de

Production

Druck Ring GmbH & Co. KG,
Kirchheim near Munich

Photo Credits

Richard Pürcher, Rolf Marke, Plansee Group
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