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APR 2023 VOLUME 13 NUMBER 1

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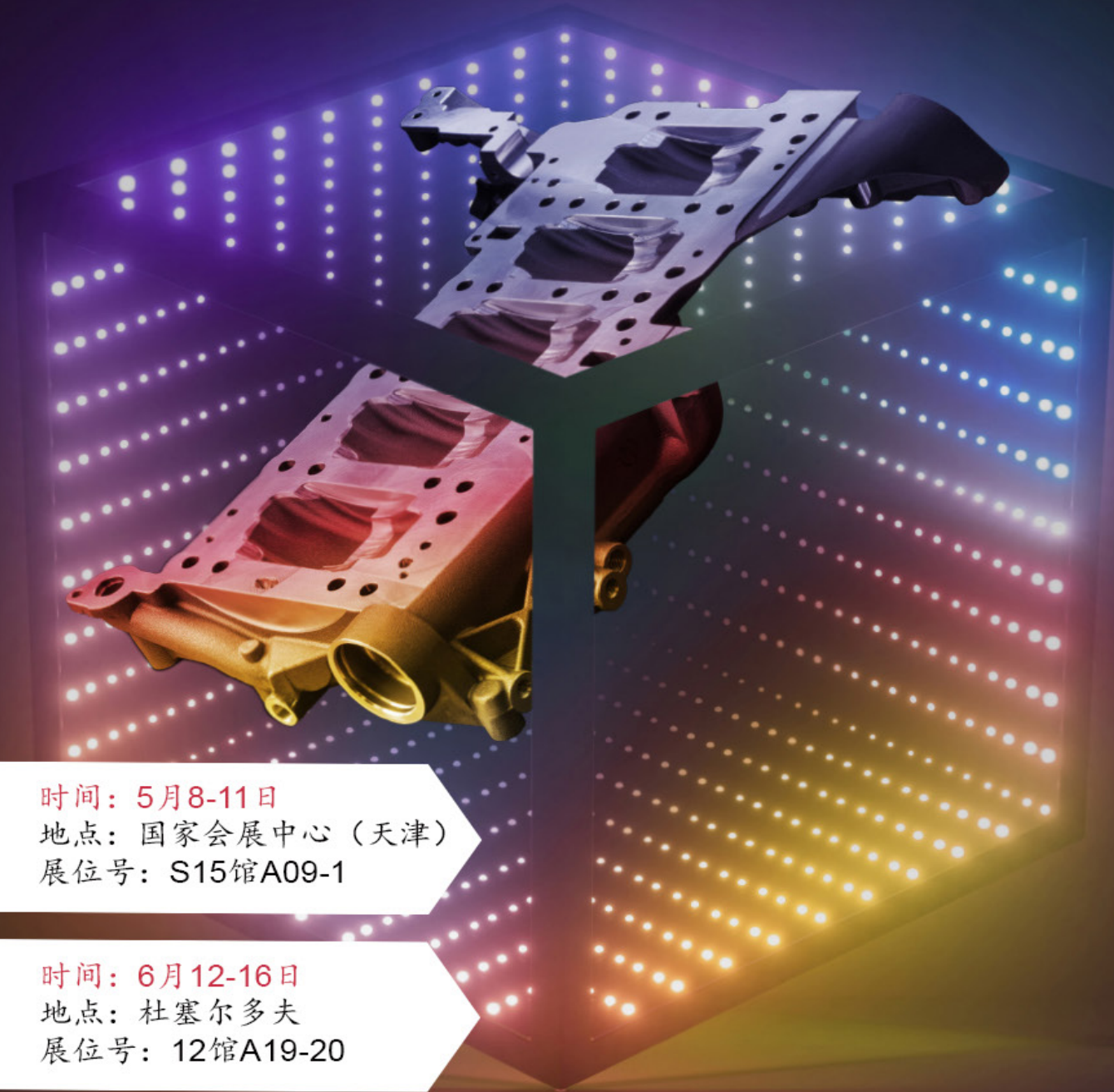
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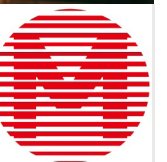
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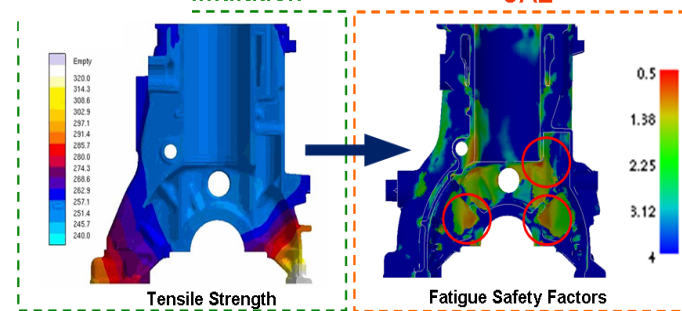
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Wencan Group's 9000T Rear Floor Megacasting Offline

文灿集团 9000T 一体化压铸后地板下线

On March 16, 2023, the "Wencan's Rear Floor Megacasting Offline and Procurement Signing Ceremony" was held at Wencan Group's Nantong Production Base. The megacasting produced this time is a large integrated die-casting rear floor with a 9000T die-casting island developed by Wencan Group for SERES Automobile.

At the event, Wencan Group also signed a "Equipment Procurement Framework Agreement" with Shenzhen Lingwei Technology Co., Ltd., a subsidiary of LK Group. Wencan will purchase 38 customized large tonnage die-casting machines from the company. The subsequent equipment procurement will be signed with the subsidiary company under this agreement, and it is expected to be finished within 2 years.

Mr. ZHANG Libo, President of China Foundry Association, and Mr. GAO Wei, Executive Vice President/Secretary General of the Die Casting Branch, attended the event, delivered speeches and presided over the ceremony respectively.

As three leading enterprises in the industrial chain, the strong alliance of Wencan Group, LK Group, and SERES Group, will effectively promote a new round of high-speed growth of the die-casting industry in China. ■

2023年3月16日，文灿集团股份有限公司“超大型一体化铸件下线暨超大型压铸机采购签约仪式”在文灿集团南通生产基地举行。据了解，此次下线的超大型一体化铸件，系文灿集团为赛力斯汽车开发的大型一体化压铸后地板，采用9000T压铸岛生产。

活动上，文灿集团还与力劲集团子公司深圳领威科技有限公司签订《设备采购框架协议》，向其采购公司定制的大吨位压铸机38台，后续设备采购将由公司下属子公司在本协议项下签订具体的设备采购合同，预计2年内完成设备提货。

中国铸造协会会长张立波，执行副会长/压铸分会秘书长高巍出席活动，分别致辞和主持仪式。

文灿集团、力劲集团与赛力斯集团作为产业链三家头部企业的强强联合，将有效促进中国压铸产业新一轮的高速增长。■

Xusheng Invests in Mexico

旭升股份投资建设墨西哥生产基地

In order to meet the needs of overseas business, expand the North American market, respond quickly to local customers, and achieve rapid product delivery, Xusheng Group announced in the evening of March 28th that it plans to establish subsidiaries to invest in Mexico. The project is expected to reach a total investment of no more than 276 million US dollars.

In 2022, Xusheng Group achieved a revenue of 1.897 billion yuan in overseas business, accounting for 42.59% of the company's total revenue. Through the subsequent construction of its overseas base in Mexico, the company's overseas business will be further expanded. It is reported that Tesla has announced plans to build a production capacity of 1 million units in Monterey, Mexico, and plans to introduce multiple models such as low-price platforms. Xusheng's production base in Mexico is expected to deepen the binding relationship between both sides, fully benefit from Tesla's global expansion strategy, and further open up medium to long-term growth space. ■

旭升集团3月28日晚发布公告，拟通过分别成立子公司、孙公司最终投资建设墨西哥生产基地。项目预计累计总投资额不超过2.76亿美元。该举措旨在满足公司海外业务发展的需要，进一步拓展北美市场，快速响应当地客户技术服务及售后服务需求，实现产品的快速交付。

2022年，旭升集团实现海外业务收入18.97亿元，占公司总营收比例42.59%，通过后续墨西哥海外基地建设，公司海外业务进一步扩展。据悉，特斯拉宣布拟于墨西哥蒙特雷市建设100万台产能，规划导入低价平台等多款车型，旭升集团在墨西哥基地建设事宜落实，有望促进深化双方全球绑定关系，充分受益特斯拉全球扩张进程，进一步打开中长期成长空间。■

Jinan Kede Intelligent and Weifang Shenglin Machinery Signed Strategic Agreement

济南科德智能与潍坊晟林机械就铸造制芯智能化合作签署战略合作协议

On March 18, 2023, Weifang Shenglin Machinery Co., Ltd. and Jinan Kede Intelligent Technology Co., Ltd., signed a strategic cooperation agreement, and decided to conduct a more in-depth and extensive research and development cooperation on the implementation and application of unmanned automation and intelligent systems in core making system, which includes the automation of core making, core assembly, core repair, unmanned transportation, and intelligent production control.

At present, both companies have jointly developed commercial uses, such as fully automated one-stop intelligent production line for automotive turbocharger sand cores, automation of pick-up, repair, and assembly of brake disc sand cores, and automation of grasp, polishing, and assembly of engine block cores. At the same time, the research and development for intelligent core making departments such as "water conservancy and fire protection casting sand cores", "wide area automotive component casting sand cores", and other industrial casting sand cores are gradually being commercialized and implemented.

Weifang Shenglin is a leading manufacturer of complete sets of core making automation equipment in China. For many years, it has focused on optimizing, developing and upgrading core making production equipment continuously, and is committed to producing intelligent and top-class products for the industry.

Jinan Kede Intelligent Technology Co., Ltd. is an independent subsidiary of Meide Group, developed from the IT Center and Technical Transformation Department of the former Automation Research and Development Department of Meide Group. With 15 years of experience in intelligent manufacturing practice, innovative technology, and a research and development team of over 300 people, it is committed to providing tailored intelligent manufacturing system solutions for enterprises in the fields of intelligent factory planning consulting, industrial database building, MES, and intelligent equipment. ■

2023年3月18日，潍坊晟林铸造机械有限公司与济南科德智能科技有限公司决定就铸造行业制芯系统无人自动化、智能化的系统落地应用，进行更深入广泛的研发合作，以实现铸造企业制芯、组芯、修芯、转运无人自动化、生产管控智能化的新型铸造制芯系统，并就该领域的合作签订战略合作协议。

目前，双方已共同打造完成了包括：“汽车涡轮增压器砂芯”全自动化一条流智能生产线、“制动盘砂芯”抓取修芯排芯自动化、“发动机缸体组芯”抓取打磨组芯自动化等领域的商用实例。同时针对“水利消防铸件砂芯”“广域汽车零部件铸件砂芯”、其他工业类铸件砂芯等制芯工部的智能化研发也在逐步商用落地。

潍坊晟林铸造机械有限公司是国内领先的铸造自动化成套制芯设备制造商。多年来专注并深耕于制芯生产设备的优化研发，持续升级迭代，致力于打造智能化稳定的行业顶端产品。

济南科德智能科技有限公司，是由玫德集团原自动化研发部IT中心、技术改造部门发展而成的集团独立子公司；承接玫德集团十五年的智能制造实践经验、创新技术和300余人的研发团队，集研发、设计、生产制造、产品销售于一体。从智能工厂规划咨询、工业立库、工业MES软件、智能装备等方面为企业量身打造智能制造系统解决方案。■

industry. At the Buhler factory in Wuxi, China, the production line was upgraded and rebuilt last year to produce the large megacasting solutions.

The Carat 920, with a locking force of 92,000 kN, was one of these large machines that stemmed from this assembly line. On March 16, 2023, Buhler China held an Open Day to let key guests experience the Carat 920. The event saw Buhler's executives, customer representatives, and association leaders share their insights into the future of megacasting.

Mr. GAO Wei, Executive Vice President of the China Foundry Association/Secretary General of the Die Casting Branch, attended the event and delivered a speech. In his speech, he congratulated Buhler on the successful opening of the Die Casting Open Day and fully recognized Buhler's contribution to the industry as the Vice Chairman unit of the Die Casting Branch. He mentioned that Buhler Group provides a one-stop die-casting solution for a large number of die-casting enterprises, such as SmartCMS, myBuhler customer service platform, and so on. He said, "As an association platform, we highly encourage and support the coordinated development of the industry chain."

Megacasting is a revolutionary course in the die-casting industry. With this technological development, the body-in-white of the car can be manufactured in a more efficient and sustainable way. For example, the die-casting solution for automotive structural parts has made great progress, from the mass production of structural parts such as shock towers in the initial stage to those requiring complicated processes, such as rear-side members. There is no doubt that, as the industry is driven by the aim to cut costs and increase benefits, die-casting progress will certainly bring huge benefits. ■

压铸的发展趋势，整个压铸产业链上下游纷纷开始布局。2022年，布勒压铸工厂为了实现更大吨位压铸机的生产，完成了产线升级改造。

2023年3月16日，布勒压铸工厂举办了Carat 920开放日活动，这场被誉为“总身价超过2000亿的开放日”引来国内外多家头部汽车整车厂、压铸厂及产业链上下游合作企业参加此次活动。活动现场，布勒领导、客户代表及行业协会的领导对未来一体化压铸的发展趋势及布局发表了各自的见解。

中国铸造协会执行副会长/压铸分会秘书长高巍出席活动并致辞，他在发言中对布勒压铸开放日的成功召开表示祝贺，并充分肯定了布勒作为压铸分会的副理事长单位对行业做出的贡献。提到布勒集团为广大压铸企业提供一站式的压铸解决方案，高巍如数家珍，SmartCMS压铸岛智能管理系统、myBuhler客户服务平台等等。他表示，“作为协会平台，我们非常鼓励和支持这种产业链的协同发展”。

在压铸行业，一体化是非常重要的变革。这意味着行业技术的拓展和整合将逐步取代部分冲压技术，一体化压铸将带来更好的制造效率和轻量化，促进行业发展。压铸行业的发展也势必会带来更多的机遇和收获。这些机遇包括提高工艺水平、扩大生产范围和增加竞争力。例如，汽车结构件压铸生产技术已经取得长足进步，从初期的减震塔等结构件大批量生产后，已经扩展至后地板等工艺难度比较大的结构件。毫无疑问，在降本增效的行业发展驱动下，压铸行业的发展也将带来巨大的收益。■

Die Casting Industry's High Quality Development Summit Held in Zhaoqing

中国新能源汽车压铸产业高质量发展峰会在肇庆举行

On March 28th, the high-quality development summit on China's new energy vehicle die-casting industry was held in Zhaoqing, with the theme of "Zhaoqing Foundry for Future Intelligent Manufacturing". China Die Casting Industry High Quality Development Alliance was established during the meeting, which opens a new chapter of digital transformation and upgrading of the die casting industry.

The summit is hosted by China Foundry Association, China Mechanical Engineering Society, and organized by

3月28日，以“肇庆铸造 智造未来”为主题的中国新能源汽车压铸产业高质量发展峰会在肇庆举行。在会上，中国压铸产业高质量发展联盟成立，开启压铸产业数字化转型的新进程。

峰会由中国铸造协会、中国机械工程学会主办，肇庆市高要区人民政府、新华网广东有限公司、广东省铸造行业协会等单位承办。

Bühler Carat 920 Megacasting Equipment Unveiled

布勒第一台 9200T 压铸机下线

In recent years, the rise of megacasting has catalyzed the upstream and downstream businesses of the die-casting

随着一体化的进程推进，压铸行业用户对一体化的压铸产品追捧是一个关键的变化。近年来，随着大型一体化

the People's Government of Gaoyao District of Zhaoqing City, Xinhuanet Guangdong Co., Ltd., Guangdong Foundry Industry Association.

The die-casting industry in Zhaoqing, which may be overlooked for a long time, is one of the key industries in Zhaoqing City. Currently, there are more than 100 die-casting industry related enterprises and nearly 20000 employees in the city. Last year, the die-casting industry output value was RMB 27 billion yuan.

Mr. ZHANG Libo, President of China Foundry Association, stated that electrification, networking, and intelligence have become the development direction of new energy vehicles, and lightweight, integration,

and new ecology will become the characteristics of the die-casting industry in the new era. It is reported that the bottleneck in new energy vehicles still lies in the endurance of power batteries. Among them, the reduction of body weight, breakthroughs in production process, and the improvement of integrated die-casting technology have all played a positive role in breaking the bottleneck.

Data shows that the market volume of integrated die-casting for new energy vehicles in China in 2022 was RMB2.15 billion yuan, and it is expected to reach RMB13.58 billion yuan by 2024. The overall market size is expected to exceed 80 billion yuan by 2027.

Promoting the lightweight of car bodies

Mr. DING Wenjiang, an academician of the CAE Member and director of the Hydrogen Science Center of Shanghai Jiaotong University, said that large structural die-casting is an important part in the development of new energy vehicles, which breaks through the limitations of the traditional die-casting process, realizes the integrated manufacturing of parts, and promotes the development of new energy vehicles.

According to the report, the advantages of integrated die-casting technology for new energy vehicles lie in low investment in production equipment, high material recovery rate, and reduction of labor. It has reduced the need of welding and auxiliary equipment, robots, etc.. And the production of white body is achieved with only 3-5 large die-casting machines, a small number of auxiliary machines and molds. The components produced do not require transportation and can be directly supplied in the factory. The material utilization and recycling rate of the aluminum body can reach 95%. While in welding factories, 200 to 300 workers are usually required, but after the reform, only about 30 to 40 people are required. The efficiency of stamping and welding has been increased by more than 10 times,



可能被外界忽略的压铸产业是肇庆市的重点发展产业之一，目前全市有压铸产业链企业 100 多家，从业人员近 2 万人，去年压铸工业产值 270 亿元。

中国铸造协会会长张立波表示，电动化、网联化、智能化已成为新能源汽车的发展方向，轻量化、一体化、新生态将成为新时代压铸产业的特征。据悉，新能源汽车的发展瓶颈依然在动力电池的续航能力上，其中车身重量降低、生产流程的突破、车身一体化压铸技术的提升，都对于打破瓶颈起到积极的作用。

数据显示，2022 年中国新能源汽车一体化压铸件市场规模为 21.5 亿元，预计 2024 年将达到 135.8 亿元，2027 年整体市场规模有望突破 800 亿元。

推动汽车车身轻量化

中国工程院院士、上海交通大学氢科学中心主任丁文江说，大型结构压铸件是新能源汽车发展的重要部件，突破了原来压铸的限制，实现众多零部件的综合制造，推动了新能源汽车发展。

从研究报告来看，新能源汽车一体化压铸技术优势在于生产设备投入少、材料回收率高、工人数量少。它削减了大量焊接辅助设备、机器人等生产设备，白车身的生产仅通过 3-5 台大型压铸机，少量辅机及模具实现。它生产出的部件不需要运输可厂内直接供货，一体化压铸全铝车身材料利用率和材料回收利用率可达 95%。在主流焊装工厂通常配备 200-300 个工人，改革后仅需要约 30-40 人。冲压和焊装效率提升 10 倍以上，大量减少焊点、热处理与涂胶的工作量。

significantly reducing the workload of welding points, heat treatment, and gluing.

New energy vehicles gain weight by 250kg due to power batteries, motors, and electronic controls, accounting for 35% of the total vehicle weight, in which power batteries account for 20%. If the weight of new energy vehicles decreases by 100KG, not only the battery costs and losses will be reduced by 20%, but the battery can also be increased by 10%.

During the summit, "Gaoyao Initiative" for high-quality development of die-casting industry for new energy vehicle was released, proposing to promote the lightweight, intelligent, green, and high-quality development of the industry, jointly promote the application of die-casting technology in the entire industrial chain of new energy vehicle's intelligent manufacturing, promoting joint consultation, joint contribution, and win-win cooperation. ■

新能源汽车由于动力电池、电机和电控三大件增重 250kg，占整车重 35%，动力电池重占 20%。如果新能源汽车重量下降 100KG，不仅电池成本和损耗可降低 20%，而且续航还能提升 10%。

峰会发布了“肇庆铸造 智造未来”——中国新能源汽车压铸产业高质量发展《高要倡议》，提出推动新能源汽车压铸产业实现轻量化、智能化、绿色化高质量发展，共同推进压铸技术在新能源汽车智造全产业链中的应用，促进共商共建、合作共赢。■

World's First High-strength and High-rigidity Ductile Iron Cylinder Block Poured by Yuchai

全球首台高强度高刚性球墨铸铁气缸体在玉柴诞生

Recently, the world's first as cast QT900-2, ductile iron cylinder block with high-strength and high rigidity, was poured at Guangxi Yuchai Casting Co., Ltd. Its surface quality, body anatomy, and performance test results proves superior to the original gas cylinder block, and the weight is also reduced by 30%.

The main difficulties in the production of ductile iron cylinder blocks lie in the complex structure of components and significant differences in wall thickness. Due to the solidification characteristics of paste of the ductile iron, it is difficult to achieve feeding through conventional process. A large number of shrinkage cavities and porosity problems are prone to happen, which are difficult to solve through conventional processes.

On the basis of successful mass production of 3mm high-strength thin-walled flywheel shells using the iron mold sand coating instead of aluminum, Yuchai Casting has adopted the as cast QT900-2 material process to adjust and optimize various parameters, such as the pouring system of the original cylinder body, the parts prone to shrinkage and porosity, the thickness of the sand layer and iron mold, and melting. At present, the iron mold sand has been applied in flywheel shells, crankshafts, bearing covers, robot retarders, and has achieved good results. ■



近日，全球首台铸态 QT900-2 高强度高刚性球墨铸铁气缸体在广西玉柴铸造有限公司成功浇注，从气缸体毛坯表面质量、本体解剖和本体性能测试结果看，均优于原气缸体，重量也减轻了 30%。

球墨铸铁气缸体的生产主要难点在于零部件结构复杂、壁厚差异大。由于球墨铸铁是

糊状凝固特性，很难通过常规补缩工艺实现补缩，气缸体极易产生大量的缩孔和缩松问题，用常规工艺很难彻底解决。

玉柴铸造在采用铁型覆砂工艺成功批量生产出 3 毫米高强度薄壁化飞轮壳代铝基础上，本次采用铸态 QT900-2 材质工艺，对原气缸体浇注系统、容易产生缩松部位对覆砂层厚度和铁型厚度及熔化等诸多工艺参数进行了调整和优化，取得圆满成功。目前该工艺材料已应用在飞轮壳、曲轴、轴承盖、机器人减速器等轴类、壳体类铸件产品中，取得了较好效果。■

AYD Foundry Invests in New Disa Production Line

AYD 铸造公司购入新迪砂线

Capacity increase for brake disc production

AYD Foundry under the umbrella of AYD Automotive is one of Turkey's leading foundries aiming to grow further in the global brake disc market.

On 24 February 2023, the 2nd Disa D3-555 Klp production line was commissioned in the presence of the Chairman of the Board Mr. Harun Aydın-General Manager Mr. Halil Aydın and other executives.

With the new line, AYD Foundry will increase its annual capacity to 55 thousand tons, serving 1500 different references with 6,000,000 units per year.

This will achieve the first short-term target in brake disc production and 100% processing capacity, and in the following period, the medium-and long-term target is to produce 25,000,000 units of brake discs.

The company is creating more jobs and added value in the Turkish economy with the capacity increase. ■

提升制动盘产能

AYD 汽车公司旗下的 AYD 铸造厂是土耳其领先的铸造企业之一，旨在全球制动盘市场获得进一步发展。

2023 年 2 月 24 日，第二条迪砂 D3-555 Klp 生产线在公司董事会主席 Harun Aydın 先生、总经理 Halil Aydın 先生和其他高管的见证下投产。

有了新的生产线，AYD 铸造厂的年产能将增加到 5.5 万吨，每年为 1500 家客户提供 600 万套产品。

这将实现制动盘生产的第一个短期目标以及 100% 加工能力，接下来，公司的中长期目标是达到生产 2500 万套制动盘的目标。

随着产能的增加，公司为土耳其经济增长创造了更多的就业机会和附加值。■



First Pour in UzAutosanoat Brand New Foundry

UzAutosanoat 公司的全新铸造厂成功浇注

On the 1st of February 2023, the first iron casting was made in a new foundry established by UzAutosanoat (the biggest automotive manufacturing company in the CIS, producing all range of vehicles and components to them). The new foundry was named after a famous character (KOVA) in "Shahnameh" ("Book of Kings") written in the year 1010 by Persian writer Firdawsi.

The foundry was designed and engineered by the U.S. Foundry Solutions & Design (FS&D) in collaboration with local specialists from UzAutosanoat. Under the same roof No-bake (furan) and Greensand.

It is located in a city called Andijan – the heart of automotive industry of Uzbekistan where main steel scrap material is formed in UzAuto's stamping plants so then to be supplied to the new foundry. It consists of Melting, molding, fettling/painting and machining shops covering more than 27,000 square meters

Several expansion stages with top suppliers from all over the world

The foundry is being built in 2 stages with more than 25,000 tons of good casting capacity per year. In the first stage 12 moulds / hour (1200 x 1000 x 350 / 350 mm) No-Bake fastloop line (by Omega Sinto) and Hanger type shotblast (by Gostol tst) was installed to produce castings for agricultural machinery parts ranging from 0,5 kg to 500 kg and additionally to be able to pour up to 2,000 kg parts on its floor molding area.

Top suppliers of the foundry equipment all over the world took part in this project – 4 furnaces with 12 tons/hr capacity 'power sharing' induction furnaces by Inductotherm, vibrating chargers by General Kinematics (CYRUS), engineering cranes by Konecranes and etc.

The second stage of the project will be launched by the end of 2023. Greensand side of the project is being carried out by HWS (125 molds/hr-molding line), DISA (100 tons / hr – sandplant), Wheelabrator (shotblast) and Progelta (tundish pouring system).

Greensand molding line will be producing brake discs, drums, knuckles and crankshafts for the locally manufactured vehicles of UzAuto (Chevrolet brand).

The 6000 square meters machining shop was designed by Fujiwa machinery industry (China) including 4 automatic robotic cells-32 CNC lathe and milling machines, 4 balancing equipment, washing anti-rust equipment and magni C40 painting line.

In favor of quality control there are 3 laboratories in the

2023 年 2 月 1 日，UzAutosanoat 公司（独联体国家最大的汽车制造公司，生产各种汽车及其零部件）的新铸造厂成功浇注了第一个铸件。新铸造厂以波斯作家费尔道西于 1010 年创作的《国王之书》中的一个著名人物（KOVA）命名。

该铸造厂由美国 Foundry Solutions & Design (FS&D) 及 UzAutosanoat 公司的本地专家合作设计，包括自硬砂（呋喃）和湿型砂两种工艺。

新铸造厂位于安集延市，安集延是乌兹别克斯坦汽车工业的中心，钢铁废料主要集中在 UzAuto 的冲压厂，然后供应给新的铸造厂。铸造厂由熔炼、造型、补修/喷漆和机加工车间组成，占地 27000 多平方米。

与来自世界各地的顶级供应商合作的发展阶段

铸造厂分两个阶段建设，年产能超过 25000 吨。在第一阶段，安装了 Omega Sinto 公司的自硬砂快速循环生产线，生产能力为 12 型/小时 (1200x1000x350/350mm)，以及悬挂式抛丸机 (Gostol tst)，用于生产 0.5 公斤至 500 公斤的农业机械铸件，此外，还可以在其地面造型区浇注 2000 公斤的铸件。

世界各地先进的铸造设备供应商都参与了该项目——应达的 4 台 12 吨/小时容量的“功率共享”感应炉、General Kinematics (CYRUS) 的振动加料机、Konecranes 的工程起重机等。

该项目的第二阶段将于 2023 年底启动。该项目的湿型砂项目由 HWS (125 个砂型/小时) 的造型线、迪砂 (100 吨/小时的混砂机)、维尔贝莱特的喷丸机和 Progelta (自动浇注系统) 执行。

湿型砂造型线将为当地生产的 UzAuto (雪佛兰品牌) 汽车生产制动盘、制动鼓、转向节和曲轴。

这座 6000 平方米的加工车间由富士和机械工业 (中国) 设计，包括 4 个自动机器人单元——32 台数控车床和铣床、4 台平衡设备、洗涤防锈设备和 magni C40 涂装线。

为了进行质量控制，铸造厂有 3 个实验室——金属材料实验室、砂检测实验室和机械加工车间实验室，能够提



foundry – metal lab, sand lab and machining shop lab being able to provide 26 types of tests.

We are happy about this great insight into the new foundry in Uzbekistan and wish the responsible entrepreneurs, engineers, foundrymen and workers good luck! ■

供 26 类检测。

我们对乌兹别克斯坦新铸造厂的远见卓识感到高兴，并祝愿这些负责任的企业家、工程师及铸造工人好运! ■

Calderys' Expertise Brings Safe, Sustainable And High-Quality Innovation To The Foundry And Refractory Sectors

凯得力公司秉持专业为铸造和耐火材料行业带来安全、可持续和高质量创新

High temperatures imply high energy. In a world striving to reduce carbon emissions, high temperatures also create a challenge – one that Calderys is prepared to solve.

Calderys is a leading provider of high-quality, efficient and sustainable solutions for high temperature industrial applications. It specializes in thermal protection for industrial equipment, with a range of refractory products, as well as solutions that enhance steel

高温意味着高载能。在全球都努力减少碳排放的时刻，高温既是挑战——凯得力公司准备解决的挑战。

凯得力公司是一家为高温作业提供高质量、高效和可持续发展的解决方案的优秀供应商。专业从事工业设备高温下的保护，拥有一系列耐火产品，以及增强铸钢件冶金流动性和成

casting, metallurgical fluxes and molding processes. For the foundry industry, it is a one-stop-shop for all aspects of metal processing: from melting through to treatment and transfer, for both ferrous and non-ferrous applications.

Calderys is the fruit of over 100 years of field experience and innovation in high temperature operations. Leveraging the combined knowledge of its global network of experts, Calderys has always tailored its solutions to the needs of its customers. The company is now a privately owned standalone organization which is joining force with HarbisonWalker International, the largest supplier of refractory products and services in the United States to create a leading world-class refractories solutions provider with increased reach and scale.

Calderys' footprint in China: decades of services to the high temperature industries

Calderys' history in bentonite solutions for the molding shop dates back to 1998 when one of its precursor companies, S&B, expanded into the country. S&B would go on to be acquired by Imerys in 2015, becoming Imerys Metalcasting Solutions, now integrated to Calderys.

For the melting solutions, the presence in China began in 2002 in Shanghai. In 2005, the Imerys group acquired part of the activities of Plibrico International and Lafarge Refractories. Under the merger of these two activities, Calderys was born.

Today, Calderys offers refractories solutions for the melting shop thanks to its production site in Zhangjiagang (Jiangsu Province) which opened in 2006. The plant was ISO 9001 (quality management) certified in 2012 and ISO 14001 (environmental management) certified in 2013. It now employs more than 90 people, and produces annually more than 30,000 tons of refractory products for about 500 customers.

Concerning the molding shop, the company's advanced products and services enhance the metal casting processes of its foundry customers thanks to its production site in Jianping (Liaoning Province).

Refractory solutions for the melting shop

Calderys' expertise in the refractory sector goes all the way back to 1908. The technology has advanced significantly since then, but Calderys remains at the forefront of refractory technology for the foundry's melting shop, supplying a full range of refractory solutions, customizable to the unique requirements of the foundries.

Calderys China Vice President, Fiona Yang, leads Calderys China's business operation, from new business development to customer satisfaction.

F. Yang reflects on how Calderys is adapting in an ever-changing world. "It is thanks to our commitment to continuous innovation and our willingness to embrace new technologies that Calderys is able to keep growing and responding to our customers' evolving needs, especially linked to climate change," she says. "With rapid technological change and global net-zero carbon emission targets, we are powering new solutions to create value for customers while respecting our environment."

Silica Mix refractories is a good example of a solution

型工艺的解决方案。对于铸造行业来说，包括黑色和有色金属的应用，它是金属熔炼各环节一站式的供应商：从熔化处理到转运。

凯得力公司有 100 多年高温作业经验和创新的成果。利用其全球专家网络的综合知识，凯得力公司一直根据客户的需求定制解决方案。公司现在是私营的独立公司，正在与美国最大的耐火产品和服务供应商哈宾逊沃克国际公司合作，扩大范围和规模，成为领先的世界级耐火材料解决方案供应商。

凯得力公司在中国的发展：几十年来不间断服务于高温行业

凯得力公司膨润土业务解决方案方面的历史可以追溯到 1998 年，当年随其前身公司艾斯比永同昌公司扩展到中国。艾斯比永同昌公司在 2015 年被益瑞石集团收购，成为益瑞石集团金属铸造板块供应商，现在又回归到凯得力公司。

作为熔炼工艺解决方案，2002 年在上海开始业务。2005 年，益瑞石集团收购了派力固国际公司和拉法基耐火材料公司的部分业务。在这两家公司的合并下，凯得力公司诞生了。

目前，凯得力公司 2006 年开业的位于张家港（江苏省）的工厂，为熔炼作业提供耐火材料解决方案，2012 年通过 ISO 9001（质量管理）认证，2013 年通过 ISO 14001（环境管理）认证，现有员工 90 余人，年生产耐火产品 3 万余吨，服务 500 多家客户。

在服务造型工部方面，公司在建平县（辽宁省）生产基地提供先进的产品和服务，提高了其铸造客户的金属铸造工艺。

熔炼车间耐火材料解决方案

凯得力公司在耐火材料行业的专业生产一直可以追溯到 1908 年。那时，耐火材料工艺取得了显著的进步，目前，凯得力公司仍然处于铸造厂熔炼工部耐火技术的前沿，提供全方位的耐火材料解决方案，可定制服务铸造厂的特殊要求。

凯得力（中国）公司副总裁杨凤女士全面负责凯得力公司在中国的业务运营，不断发展新业务达成客户满意。

杨总回顾了凯得力公司是如何在不断变化的市场中适应的。“由于我们致力于持续创新，以及我们接受新技术的意愿，客户能够保持增长，并应对客户不断变化的需求，特别是与气候变化相关的需求。”她说，“随着快速的技术迭代和全球净零碳排放目标，我们正在推动新的解决方案，在尊重环境的同时为客户创造价值。”

凯得力公司创新的硅混合耐火材料是一个很好的例子，它适合铸造厂的工艺。

developed by Calderys that is tailored to the foundries' processes.

SILICA MIX refractories: tailored to the coreless induction furnace

Ensuring the availability, reliability and safety of coreless induction furnace (CIF) operations is essential within the casting process. Central to this is the approximate 100mm-thick working refractory lining. This separates the water-cooled coil from the molten metal, which reaches temperatures of up to 1,600°C. Failure of this lining is not an option: it would result in catastrophic damage to the CIF, putting workers at risk and leading to an extended stop in production.

Calderys produces its silica-based refractory solutions, SILICA MIX thanks to a unique position. Firstly, from high-quality quartzite that can be found at Calderys' quarry in Sweden's Dalsland region and, secondly, thanks to the production capacity of the production site in Åmål, just a few minutes away from the quarry. This exceptional material is the highest-grade raw material for silica-based refractories in the world and offers a range of unique properties:

- Excellent refractoriness (about 1,700°C) and resistance to thermal shock, reducing the risk of cracking to the lining.
- Ultra-low surface porosity when sintered, reducing the risk of steam ingress through the lining and damage to the coil.
- Strong resistance to chemical attack.
- Relatively low density, resulting in low heat loss.
- High (acidic) pH, making it compatible with most iron slags

These qualities offer enhanced protection of CIF components and increase the operating life of SILICA MIX refractories when compared to other furnace lining solutions. Time between maintenance stops is therefore extended with SILICA MIX – helping to maximize furnace uptime.

Calderys also developed a boron-free SILICA MIX product that matches the performance characteristics of standard SILICA MIX products. In trials, these products showed no signs of cracking or ingress of molten iron, even after a high number of heats and in one-shift operations, where continuous cycles of heating and cooling place significant stress on the lining.

High-quality bentonite at the heart of Calderys' solutions for the molding shop

Calderys' offer includes a wide range of solutions for the molding shop based around high-quality bentonite reserves. Bentonite is supplied to the Chinese market from Calderys'.

Jianping quarry and factory site in Liaoning, which expanded in 2020 to double the capacity of the dryer and install new milling capacity. The high grade of raw material is characterized by high thermal durability, high green compression strength and high wet tensile strength. Annual production stands at 250,000 tons, supplying about 300 customers in China.

The Jianping quarry contains 2 million tons of high-quality bentonite raw ore reserves, which can ensure a continuous supply of high-quality products to foundry customers. The management of this quarry is considered a benchmark in the industry, thanks to the company's mine restoration and management programs.

After nearly 10 years of working hand in hand with the

硅混合耐火材料：适用于无芯感应炉

确保无芯感应炉（CIF）作业的可用性、可靠性和安全性在铸件生产过程中至关重要。这其中的核心是大约 100mm 厚的耐火炉衬的工作层。耐火炉衬将水冷线圈与温度高达 1600°C 的熔融金属分离。这种炉衬的失效是不可接受的：将给企业造成灾难性的破坏，使工人处于危险之中，并导致长时间停产。

凯得力公司提供的硅基耐火材料解决方案，得益于二氧化硅混合物的独特位置。首先，在瑞典达尔兰地区的凯得力公司采石场可以找到高质量的石英岩，其次，由于阿迈勒生产基地的生产能力，距离采石场只有几分钟的路程。这种特殊的材料是世界上最高等级的硅基耐火材料的原料，并具有一系列独特的性能：

- 优异的耐火性（约 1700°C）和抗热冲击，降低了炉衬开裂的风险。
- 烧结时表面超低孔隙率，减少了蒸汽通过炉衬进入和损坏线圈的风险。
- 强的耐化学腐蚀。
- 相对较低的密度，热损失较低。
- 高（酸性）pH 值，使其与大多数铁渣兼容。

与其他炉衬材料相比，这些特性提供了更强的保护，提高了二氧化硅混合耐火材料的使用寿命。因此，二氧化硅混合材料使停炉维护间隔的时间延长 – 有助于最大限度地提高熔化炉的正常作业时间。

凯得力公司还开发了无硼二氧化硅混合产品，符合标准二氧化硅混合产品的性能特性。在试验中，即使在多次的加热和转运操作中，这些产品没有显示出开裂或熔融铁液侵入的迹象，连续的加热和冷却循环对炉衬造成显著的应力。

高质量的膨润土是凯得力公司为造型车间提供解决方案的核心

基于高质量的膨润土储备，凯得力公司为造型工部提供广泛的解决方案。膨润土从凯得力公司位于辽宁省建平县的采石场和工厂供应中国市场，2020 年扩大的烘干机产能增加一倍，并安装了新的铣磨设备。高等级的原料具有热耐久性高、湿抗压强度高、湿抗拉强度高特点。年产量为 25 万吨，供应中国约 300 名客户。

建平县采石场拥有 200 万吨优质膨润土原矿储量，可确保向铸造客户持续供应高品质产品。由于公司的矿山恢复和管理项目，该采石场的管理被认为是行业的标杆。

经过与铸造行业近 10 年的携手工作，凯得力公司已成为亚洲主要的铸造用膨润土供应商之一。公司为造型工部提

foundries, Calderys has become one of the major foundry bentonite suppliers in Asia. The company's molding shop solutions offer foundries the opportunity to improve casting quality and reduce scrap and rework rates – with knock-on benefits for energy and resource efficiency, as well as cost reduction. The products can be tailored to meet customer requirements, with activation precisely controlled to ensure stability. For green engineering blends, Calderys experts formulate specific bentonite-based solutions based on site visits and thorough analysis.

Calderys is a true one-stop-shop for foundries, offering high technical expertise from the melting shop all the way down to the molding shop. Leveraging a global network of expertise with local points of contact, Calderys works hand in hand with the foundry shop and has - over the decades - become a true partner to the foundry men and women.

Calderys Zhangjiagang takes the lead in environmental protection and workers' health

Calderys opened its Zhangjiagang Plant in Jiangsu Province in 2006 to produce refractory products for the Chinese market. In 2021, the plant achieved a first for the refractory industry, when it was recognized by the provincial government for leadership in environment protection.

That journey had begun five years earlier, when the plant improved the quality of its raw materials. The new materials contain significantly less water, allowing the Zhangjiagang.

Plant to reduce the use of its natural gas-fired drying kiln – a step that substantially reduced energy consumption and related carbon emissions. In total, natural gas use fell by 23,000m³ per year.

In addition, the plant improved its dust control measures, using dust-proof partitioning to protect workers from exposure to airborne particles, and dust extraction systems to collect dust for disposal. Airborne dust concentrations now average 4.3mg/m³ compared to the national regulatory standard or 120mg/m³.

In March 2023, Calderys China was listed as an Environmental Protection Demonstration Enterprise by the Suzhou Ecological Environment Bureau, thanks to the teams' efforts in dust control, management of dangerous chemicals, and overall environmental compliance. The Bureau's list of enterprises includes 156 companies. The accreditation aims to encourage companies and institutions to play a positive leading role in ecological and environmental protection.

Visit Calderys at METAL CHINA 2023 and GIFA 2023

Calderys will present its products and services at two upcoming trade shows for the foundry industry. Metal China 2023, is being held on May 8th and 11th in Tianjin. Calderys foundry and aluminum experts will be at stand S15-C03.

Meanwhile GIFA – the leading international Trade Fair for the foundry industry – will take place on the 12th to 16th of June in Düsseldorf (Germany), with Calderys in Hall 10, stand C72. ■

供的解决方案，提高了铸件质量和减少废料和返工——以提高能源和资源效率，以及降低成本。产品可根据客户的要求进行定制，精确控制激活，以确保稳定。对于粘土湿型砂工艺，凯得力公司的专家们根据实地考察和彻底分析制定具体的基于膨润土的解决方案。

凯得力公司是铸造行业真正的一站式解决方案供应商，提供高技术的专业知识，从熔炼一直到造型。利用本地联络点和全球专业网络，凯得力公司与铸造行业携手合作，并在几十年里成为铸造人真正的合作伙伴。

凯得力公司张家港工厂在环保和员工健康方面处于领先

凯得力公司于 2006 年在江苏设立张家港工厂，为中国市场生产耐火材料产品。2021 年，工厂首次进入耐火材料行业，获得了省政府环保领导能力的认可。这段旅程始于五年前，当时工厂提高了原材料的质量。新材料的含水量明显减少，使张家港工厂减少天然气干燥窑的使用，这一步骤大大降低了能耗和相关的碳排放。天然气使用量每年累计减少 2.3 万立方米。

此外，工厂还改进了其防尘措施，使用防尘隔板来保护工人不暴露于空气中的粉尘，以及使用除尘系统来收集灰尘并处理。空气中的粉尘浓度现在平均为 4.3 mg/m³，而国家标准中的粉尘浓度为 120 mg/m³。

2023 年 3 月，由于团队在防尘、危险化学品管理、全面环保等方面的努力，凯得力（中国）公司被苏州市生态环境局列为环保示范企业。该局的企业名单包括 156 家公司。该认证旨在鼓励企业和机构在生态 and 环境保护方面发挥积极的领导作用。

欢迎光临凯得力公司在中国国际铸造博览会和德国国际铸造展览会展位

凯得力公司在即将到来的两场铸造行业贸易展上展示其产品和服务。中国国际铸造博览会将于 2023 年 5 月 8-11 日在天津举行。凯得力公司铸造厂和铝专家将在展位 S15 馆 C03 展位。

与此同时，铸造行业领先的国际贸易博览会将于 6 月 12-16 日在杜塞尔多夫（德国）举行，凯得力公司在 10 号馆 C72 展位。■

WELCOME TO CALDERYS

We are a leading global provider for industries operating in high temperature conditions. Pushing the boundaries of innovation and excellence, we deliver high-quality materials and services adapted to the foundries' melting & molding shops.

Hungarian Die Caster Cuts Energy Consumption By 26% with OEM Furnace Relining From Strikowestofen

匈牙利压铸机通过史杰克西的 OEM 换炉 将能耗降低 26%

Based in Hungary, FÉMALK Zrt. has been supplying the global automotive industry with high quality aluminium castings for almost 30 years.

Melting up to 4000 tons of aluminium per month to produce parts ranging from engine and gearbox supports, suspension components and electronic covers, to headlight and thermostat housings, FÉMALK needs its melting and dosing furnaces to operate with high levels of energy efficiency. Even after years of service.

To see where potential savings and sustainability gains could be achieved through equipment modernization options, the Hungarian die caster approached long-term supplier StrikoWestofen, via local agent PRACTILUB Professional Zrt., to review equipment and identify opportunities.

Melting furnace: exceeding energy reduction expectations

FÉMALK asked StrikoWestofen to start by looking at a 12-year-old StrikoMelter shaft melting furnace in need of relining.

StrikoMelter is energy efficient design, as hot waste gases from the melting process are used to preheat the melting material in the EtaMax shaft prior to the actual melting process. Ideal for helping die casters achieve their sustainable casting goals.

But as with any melting furnace, mechanical and thermal stress caused by temperature deviations, charging materials and dross, make refractory relining an inevitable and necessary process for maximizing furnace lifespan, optimizing melting performance and avoiding damage-related energy loss.

Based on performance tests carried out in partnership with FÉMALK prior to relining, StrikoWestofen identified that energy savings of 22% could be achieved with a full relining of the furnace melting chamber and partly cosmetic repair of the holding chamber. Not enough, further energy saving options had been carried out such as the optimization of the melting process.

The StrikoMelter was removed, relined, re-installed and tested under full operational conditions in less than 4 weeks, with results showing that the energy consumption per ton of molten aluminum had been reduced by 26%, significantly above the target set.

Bence Gölöncsér from FÉMALK commented:

近 30 年来，总部位于匈牙利的 FÉMALK Zrt 公司为全球汽车行业提供了高质量的铝合金铸件。

FÉMALK 公司每月可熔炼 4000 吨的铝合金，产品包括从发动机、变速箱支架、悬架部件和电子端盖到前照灯和恒温器外壳等各种部件，并且要求其熔炼炉和定量炉即使在服务多年之后仍能高效运行。

为了了解通过设备的现代化升级可以在哪些方面实现节约以及存在的可持续性收益，匈牙利压铸企业通过当地代理商 PRACTILUB Professional Zrt. 与史杰克西公司取得了联系，了解设备并确立合作。

熔炉：超出节能预期

FÉMALK 公司要求史杰克西公司从一个已使用 12 年且需要换衬的 StrikoMelter 竖炉着手进行改造。

StrikoMelter 是一种节能设计，因为在熔炼正式开始之前，熔化过程中产生的热废气用于预热 EtaMax 轴中的炉料，是帮助压铸机实现可持续生产目标的理想选择。

但是，与任何熔炼炉一样，由于温度偏差、炉料和浮渣引起的机械和热应力，耐火材料炉衬成为可以最大限度延长熔炉寿命、优化熔炼性能、避免与损坏相关的能量损失的必然且必要的工艺步骤。

根据与 FÉMALK 公司在换衬之前合作中所做的性能测试，史杰克西公司认为，通过对熔炉的熔融室进行完全换衬以及对保温室进行部分外观修复，可以节约 22% 的能耗。不仅如此，还做了进一步的节能方案，如优化熔炼工艺。

StrikoMelter 在不到 4 周的时间内被拆除、换衬、重新安装并在完全运行条件下进行了测试，结果显示每吨熔融铝的能耗降低了 26%，大大高于设定的目标。

FÉMALK 公司 Bence Gölöncsér 评论道：“史杰克西公司从开始到最后都非常透明，我们双方通过合作，获得了更换衬里前后的真实绩效数据，从而设定和衡量目标。”

“StrikoWestofen were very transparent from start to finish, working in partnership with us to obtain true performance figures - pre and post relining - to set and measure targets.

“We knew that the saving level estimated was based on a 50:50 ratio of ingots/returns. However, operating needs meant the post-refurb testing was carried out with ingots accounting for approximately 91% of charging material. Given that this should have resulted in a lower % improvement - as charging with larger quantities of ‘new’ aluminium ingots consumes more energy - to have achieved savings greater than the target specified was very impressive. We are delighted with the results and the speed with which this project took place.”

Dosing furnace: two Westomat relinings in two weeks

As part of its energy efficiency review of FÉMALK’s equipment, StrikoWestofen also refurbished two Westomat dosing furnaces. Relining dosing furnaces with OEM parts rather than third-party alternatives has been proven to reduce energy consumption by up to 50% - a fact FÉMALK sought to capitalize on.

StrikoWestofen has developed a dosing furnace relining service which uses high quality pre-casted refractory parts. As well as improving insulation and therefore energy consumption, this approach also means relining can be carried out far quicker. This is due to the pre-casted refractory parts being delivered in a pre-sintered state, therefore speeding up the heating process once work on the furnace is complete.

Holger Stephan from StrikoWestofen said: “We completed relining work on the Westomat in less than 2 weeks, ensuring minimal disruption for the customer. At a time when energy costs are so high, the savings generated, combined with the performance improvements delivered for the StrikoMelter, will enable FÉMALK to reduce operational costs and optimize ROI on their equipment. The project also supports the customer’s focus on sustainable production.” ■

“我们知道，预估的节能水平是基于铸锭 / 返炉的 50:50 比例而确立的。然而，运营需求意味着重新加炉料后的测试是用铸锭进行的，铸锭约占填充炉料的 91%，这样获得的改善应该会很低，因为用更多的新铝锭填充炉料会消耗更多的能量，获得的节能效果高于目标，这是令人印象深刻的。我们对这个项目的成果和实施速度感到高兴。”

定量炉：两周内完成两次 Westomat 换衬

作为对 FÉMALK 设备能效考察的一部分，史杰克西公司还翻新了两台 Westomat 定量炉。事实证明，用 OEM 零件而不是第三方替代品重新更换定量炉可以将能耗减少 50%，这是 FÉMALK 公司试图寻求的效果。

史杰克西公司开发了一种使用高质量预制耐火部件的定量炉换衬服务，该服务除了可以优化绝缘性和降低能耗外，还意味着可以更快地进行换衬。这是由于预制耐火部件是在预烧结状态下交付的，一旦炉子上的工作完成，就能够加快加热的过程。

来自史杰克西公司的霍尔格·斯蒂芬说：“我们在不到 2 周的时间内完成了 Westomat 的换衬工作，确保对客户的干扰降至最低。当前企业的能源成本是很高的，该项目节约的成本，以及 StrikoMelter 的性能改进，将降低 FÉMALK 公司的运营成本并优化其设备的投资回报率。该项目还支持客户对于可持续生产的关注。” ■

Corporate Collaboration With Zeiss and A3DS for Customized Digitization in Industrial SMES

蔡司与 A3DS 合作为中小企业工厂提供定制数字化服务

Siempelkamp Foundry presents world’s largest non-contact robot measuring cell

Together with its project partners, ZEISS Industrial Quality Solutions and the startup a3Ds, the Siempelkamp Foundry presented the world’s largest non-contact robot measuring

Siempelkamp 铸造推出世界上最大的非接触式机器人测量单元

Siempelkamp 铸造公司，与两家项目合作伙伴：蔡司工业质量解决方案公司和初创公司 A3DS 一起，今天



cell to the public at large today. “With this unique and highly innovative technology we are further advancing our comprehensive digitalization strategy. We are now able to track the entire component geometry of our products, from model to casting mold, all the way to the finished casting, in a digitized manner,” explains Dr. Georg Geier, the foundry’s managing director. As a world first, the new robot measuring cell is the special pride of the world’s leading, Krefeld-based hand-casting manufacturer. It allows for the fully automated, non-contact and reliable inspection of finished components up to a weight of 240 tons. Even though the robot measuring cell is nearly as large as a tennis court, its measuring accuracy is less than 0.6 mm thanks to up to twelve million 3D measuring points. “This system is the most advanced and powerful of its kind and helps us further optimize our casting and production processes through digital technology,” Geier adds. The foundry’s customers also benefit from the new metrology: owing to the millimeter-accurate inspection of components which are several meters long and weigh several tons, the quality of the components increases in terms of sustainability and efficiency in processing and operation.

New digital metrology is also used at the beginning of the process chain

However, in the future not only the finished cast components of the Siempelkamp Foundry will be inspected for complying with the highest quality standards with millimeter precision based on digital technology. Already at the beginning of the process chain, the foundry employs 3D metrology from ZEISS Industrial Quality Solutions, which was also demonstrated today. With the ZEISS T-SCAN hawk, the foundry has considerably further expanded its possibilities

正式向公众展示了世界上最大的非接触式机器人测量单元。公司董事总经理 Georg Geier 博士解释道：“凭借这项独特且高度创新的技术，我们正在进一步全面推进我们的数字化战略。我们现在已能够以数字化的方式跟踪产品整个部件的几何形状，从模具到铸模，一直到最终铸件产品。”作为世界第一家推出新型机器人测量单元的企业，这家世界领先水平的 Krefeld-based 铸造制造商感到十分自豪。该产品可以对重达 240 吨的成品部件进行全自动、非接触式和极具可靠性的检查。尽管机器人测量单元几乎和网球场一样大，但由于其具有多达 1200 万个 3D 测量点，其测量精度可以达到低于 0.6 毫米。Geier 博士补充道：“该系统是同类系统中最先进和最强大的，可以帮助我们通过数字技术进一步优化铸造和生产流程。”铸造厂的客户也能从新的测量方式中受益：因为可以实现对部件规格进行毫米级的精确检测，精确确定需要几米长和几吨重的铸件，部件的质量在加工和操作的可持续性和生产效率方面得到了提高。

新的数字测量也被用于生产流程链的开端

然而，在未来数字化技术不仅会应用于对 Siempelkamp 铸造公司的成品铸件进行检查，以确保其符合基于数字技术的毫米精度的最高质量标准。在生产流程链的最初，该铸造公司就使用了蔡司工业质量解决方案的 3D 测量，这一点今天也进行了演示。凭借蔡

concerning optical laser metrology. The handy scanner can check the dimensions and geometries of wooden models that constitute a positive of the finished cast component with great precision and avoid errors at the very start of component production. "In this way, target and actual values can be mapped very transparently for our customers in the early stage of our production processes. This opens up previously unimagined potentials in terms of construction precision," elaborates Dirk Howe, Managing Director of the Siempelkamp Foundry. Thanks to the software platform ZEISS Quality Suite, the entire component development can be seamlessly tracked throughout the entire process in the foundry. The foundry's customers benefit from a wealth of information gained through the digital processes concerning the manufactured components, which can serve them in their further use.

Digitalization offensive succeeds thanks to strong technological partnerships

At today's presentation of the latest successes of the digitalization strategy of the Siempelkamp Foundry, Dirk Howe expressed his great pride in the developments that have been achieved together with ZEISS Industrial Quality Solutions and a3Ds. The commissioning of the technologically groundbreaking robot measuring cell, he said, constitutes the latest success in the Siempelkamp Foundry's complete concept in order to make its entire process chain more automated and digital. The Siempelkamp Foundry already set benchmarks last year by digitizing its crucible induction furnaces. By optimizing the metrology in the foundry, yet another pioneering achievement has now been implemented.

"In conjunction with our collaboration partners we have developed the world's first high-tech robot measuring cell for such large and complex components on our own initiative. In this way we are strengthening Germany as a business location for the long haul and at the same time make a notable contribution to more digitalization and automation in Germany's SMEs. We are pleased to now be offering customers throughout the world solutions of even better quality to improve their competitive edge", Howe said. ■

司 T-SCAN hawk 产品, 该铸造公司进一步极大扩展了其在光学激光测量方面的可能性。使用手持的扫描仪可以非常精确地检查木制模型的尺寸和几何形状, 这些模型构成了成品铸件的正模, 并避免了在部件生产一开始就出现错误。Siempelkamp 铸造公司董事总经理 Dirk Howe 阐述道: "通过这种方式, 在生产过程的早期阶段, 我们就可以非常直观和透明地为我们的客户投射出生产目标并展示实际价值。这在施工精度方面发掘出了以前无法想象的潜力。" 得益于蔡司质量套件软件平台, 整个组件开发可以在铸造厂的整个过程中得到严密跟踪。铸造厂的客户受益于通过数字化流程获得的与制造部件有关的丰富信息, 这些信息可以为他们的下一步使用提供支持。

强大的技术合作伙伴关系使数字化攻势取得成功

在今天介绍 Siempelkamp 铸造公司数字化战略的最新成果时, Dirk Howe 对蔡司工业质量解决方案和 a3Ds 共同取得的进步表示非常自豪。他说, 技术突破性的机器人测量单元的调试是 Siempelkamp 完整概念的最新成就展示, 目的是使其整个工艺链更加自动化和数字化。Siempelkamp 去年已经通过数字化坩埚感应炉设定了新的发展基础。现在又通过优化铸造流程的测量, 实现了另一项开创性成就。

"与我们的合作伙伴一起, 我们开发了世界上第一个用于此类大型复杂部件的高科技机器人测量单元。通过这种方式, 我们正在加强德国作为长期商业场所的地位, 同时致力于为德国中小企业的数字化和自动化做出显著贡献。我们非常期待为世界各地的客户提供更优质的解决方案, 以提高他们的竞争优势", Howe 这样总结说。■

Fully Optimised for Sustainability

全面优化可持续发展

BMW Group Plant light metal foundry recertified by Aluminium Stewardship Initiative (ASI) +++ Solar aluminium meets more than a third of light metal foundry's annual requirements +++ Almost two thirds of aluminium used comes from recycling loop

The BMW Group's light metal foundry in Landshut

宝马集团兰茨胡特轻金属铸造厂再次更新了来自《铝业管理倡议》的认证:

——太阳能铝至少可以满足轻金属铸造厂年需求的三分之一

——目前使用的几乎三分之二的铝来自回收循环

has once again been certified by an independent party for its sustainable use of aluminium – meeting the standards of the Aluminium Stewardship Initiative (ASI), an international non-profit organisation supported by environmental and industrial associations, aluminium producers and processing companies. The ASI defines sustainability criteria for an environmentally and socially responsible aluminium value chain.

"Sustainable extraction of raw materials and conscious use of resources play a key role for our in-house component production and our global supplier network," says Dr Joachim Post, member of the Board of Management of BMW AG responsible for Purchasing and Supplier Network. "Sourcing aluminium produced using solar power for our in-house component production lowers our CO2 emissions significantly. The circular economy is also key to reducing emissions and conserving natural resources. Going forward, the aim is to build our new vehicles with 50 percent secondary raw materials."

Solar aluminium meets more than a third of annual requirements

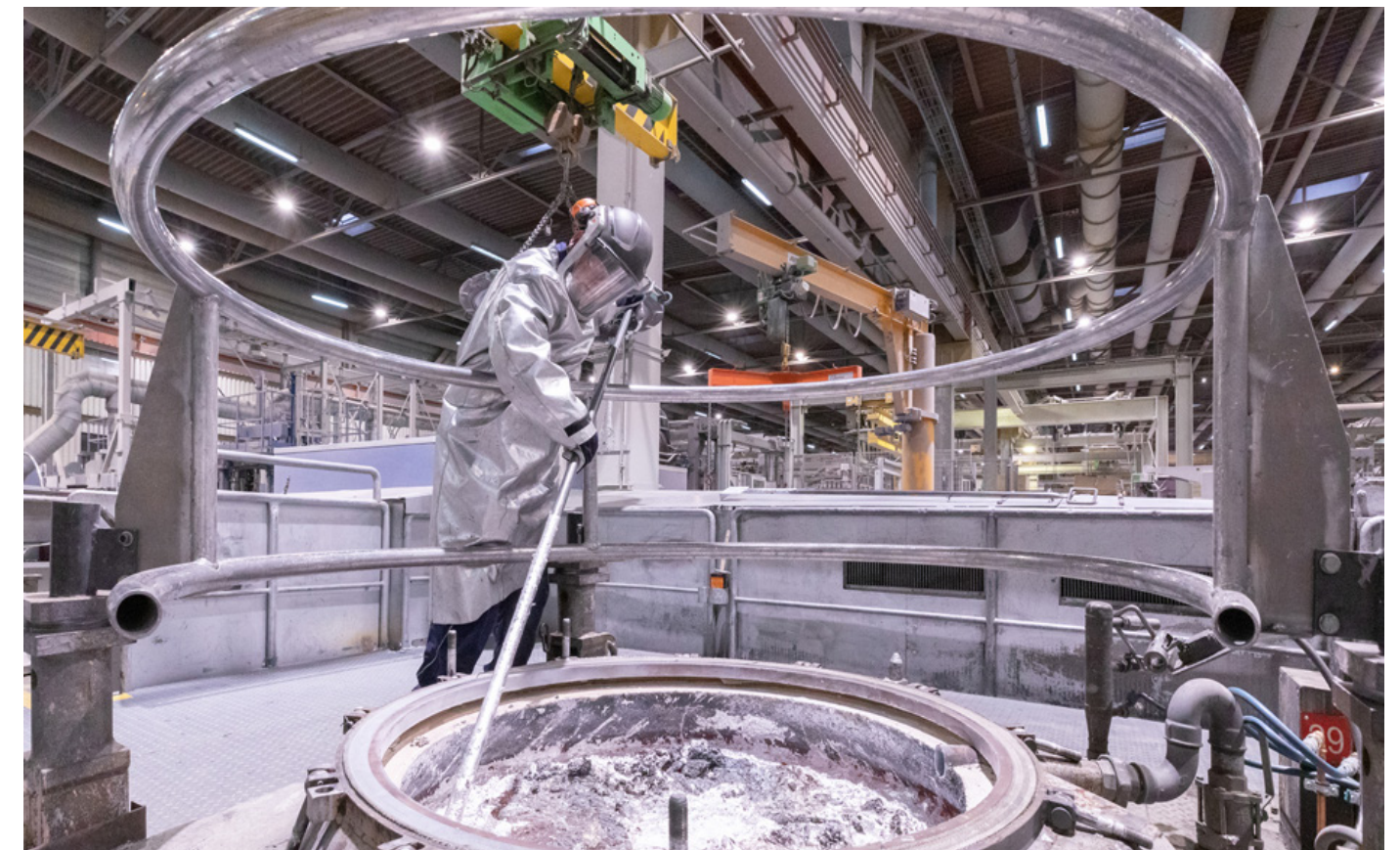
Landshut's light metal foundry, the BMW Group's only production facility for light metal casting in Europe, is among the most advanced, most sustainable foundries in the world. Thanks to its use of inorganic

宝马集团位于兰茨胡特的轻金属铸造厂, 在铝的可持续使用方面, 再次达到了独立运营机构——铝业管理倡议 (ASI) 的要求和标准, 获得了认证更新。铝业管理倡议 (ASI) 是由环境和工业协会、铝生产和加工企业支持的国际性非营利组织。该倡议制定出一系列对环境和社会负责的铝价值链的可持续性标准。

宝马股份公司采购和供应商网络管理委员会成员 Joachim Post 博士表示: "对原材料的可持续开采和对资源的有意识使用, 对于我们的内部零部件生产和全球供应商网络起着关键作用。" 通过使用太阳能完成生产过程获得的铝, 用来进行我们内部零部件生产, 这大大降低了我们的二氧化碳排放量。循环经济也是减少排放和保护自然资源的关键。在未来我们的目标是用 50% 的二次原材料来生产新车。"

太阳能铝可以满足至少三分之一的年度需求

兰茨胡特的轻金属铸造厂是宝马集团在欧洲唯一的轻金属铸件生产厂, 是世界上最先、最具可持续生产能力的铸造厂之一。由于它使用了无机砂芯, 铸造过程几乎是零排放的。该轻金属铸造厂于 2021 年开始使用太阳能生产的铝。由于铝的生产过程是高度能源密集型的,



sand cores, the casting process is virtually emission-free. The light metal foundry began sourcing aluminium produced using solar power in 2021. Since producing aluminium is highly energy-intensive, the use of green power such as solar electricity offers considerable potential for reducing CO₂ emissions. The tens of thousands of tonnes of solar aluminium supplied in this way meet more than a third of annual requirements for the light metal foundry at Plant Landshut.

CO₂-optimised recycling loop with closed foundry loop

Along with steel, aluminium accounts for the largest share, by weight, of the materials used in BMW Group vehicles. Around two thirds of the aluminium used in Landshut comes from a recycling loop – with almost two thirds of this from the foundry's own closed loop. In this way, the BMW Group is consciously reducing its use of more CO₂-intensive primary aluminium in favour of a CO₂-optimised recycling loop. Green power is also used to produce it.

The BMW Group has a long tradition of responsible use of aluminium. For more than ten years, the light metal foundry has been working with local processors to implement a recycling loop for post-production scrap metal salvaged from the foundry process. The decisive factor here is clean separation of aluminium residues. Residues are collected from all casting and mechanical processing stations according to type, so materials with different compositions are not mixed. This means that, after reconditioning, aluminium waste can be reused to manufacture the same components.

“The BMW Group has supported the Aluminium Stewardship Initiative from the beginning,” says Dr Stefan Kasperowski, head of BMW Group Plant Landshut and the light metal foundry, which is the largest production area at the plant in Lower Bavaria. “We are fully aware of our responsibility and value sustainable production of raw materials for our manufacturing.”

Last year, employees at the light metal foundry produced around 3.3 million cast components with a total weight of more than 73,000 tonnes. The scope of production includes engine components such as cylinder heads and crankcases, components for electric drive trains and large-scale structural components for vehicle bodies.

The responsibility of the BMW Group extends beyond recycling to the aluminium used. The conditions under which the raw material bauxite is extracted by open cast mining and processed in countries like Australia, Brazil and Guinea are also important to the company.

The BMW Group is in direct contact with aluminium suppliers and recycling partners in an effort to gradually expand ASI certification to the entire material cycle – starting with the producing mines.

The light metal foundry has now been certified to the ASI Performance Standard for the second time.

使用太阳能等绿色能源在减少二氧化碳排放方面具有相当大的潜力。以这种方式供应的数万吨太阳能铝可以满足兰茨胡特轻金属铸造厂年度需求的三分之一及以上。

CO₂ 优化回收循环，达成闭环铸造过程

在宝马集团汽车生产所用的材料中，铝与钢一样，按重量计算占了最大份额。兰茨胡特工厂使用的铝约有三分之二来自回收循环，其中近三分之二来自铸造厂自己的闭环应用。通过这种方式，宝马集团有意识地减少对二氧化碳密集型原铝的使用，以支持二氧化碳优化回收循环。绿色能源也被用来生产这些铝材。

宝马集团在负责任地使用铝合金方面有着悠久的历史。十多年来，这家轻金属铸造厂一直在与当地加工商合作，对铸造过程中产生的废金属实施回收循环。这里的关键性要素是铝残留物的清洗分离。残留物是根据其类型从所有铸造和机械加工流程中收集而来的，因此不同成分的材料不会被混合在一起。这意味着在重新处理后，这些铝废料可以重新用于制造相同的部件。

“宝马集团一直以来都坚定支持《铝业管理倡议》，”宝马集团兰茨胡特工厂和轻金属铸造厂负责人 Stefan Kasperowski 博士说，该工厂位于下巴伐利亚州工厂最大的生产区。“我们充分意识到我们的责任，重视我们所从事的制造业的原材料可持续生产。”

去年，这家轻金属铸造厂的员工生产了约 330 万个铸件，总重量超过 7.3 万吨。生产范围包括气缸盖和曲轴箱等发动机部件、电动传动系部件和大型车身结构部件。

宝马集团的责任感不局限于回收使用过的铝料。在澳大利亚、巴西和几内亚等国家露天开采铝土矿的条件对该公司也很重要。

宝马集团正与铝供应商和回收合作伙伴直接沟通，努力将《铝业管理倡议》(ASI) 认证的应用逐步扩展到整个材料周期——从矿山生产开始。

该轻金属铸造厂现已第二次通过《铝业管理倡议》(ASI) 性能标准认证。审计标准要求提供材料管理的证据，如公司自身产品的整体生命周期分析和全面的回收策略，以及政策执行透明度、整体管理水平和公司诚信标准等。之前，基于材料管理标准的首次成功认证是于 2019 年 12 月完成的。

报道来源：www.press.bmwgroup.com ■

The auditing criteria require evidence of material stewardship, such as a holistic lifecycle analysis for the company's own products and a comprehensive recycling strategy, as well as compliance with standards for transparency, overall management and corporate integrity. The initial successful certification in accordance with the criterion of material stewardship took place in December 2019.

Source: www.press.bmwgroup.com .” ■

Pace Industries Plans \$2.8 Million Expansion For Tennessee Plant

Pace Industries 计划斥资 280 万美元扩建田纳西工厂

Pace Industries LLC is investing \$2.8 million to expand manufacturing operations at its facility in Jackson, Tennessee. The aluminum, zinc, and magnesium diecasting manufacturer will add 49 new jobs while meeting increased customer demand from a wide range of industries. “Pace Industries has always believed that the greatest asset a company has is its employees, and through this expansion, we hope to sustain permanent growth and the financial independence of our employees while raising the quality of life experienced in Jackson,” said Pace Industries General Manager Jerry Peterson.

Tennessee Department of Economic Development Commissioner Stuart McWhorter said, “Pace Industries could have chosen to expand at any one of its locations, but it’s a testament to our state’s skilled workforce and business-friendly atmosphere that this company chose Tennessee. Jackson and Madison County have a robust manufacturing industry that will be the ideal climate to support Pace Industries’ success.” ■

Pace Industries 公司计划斥资 280 万美元，用于田纳西州杰克逊工厂的扩建。这家铝、锌和镁合金的压铸企业将增加 49 个工作岗位，满足日益增长的客户需求。Pace Industries 公司总经理 Jerry Peterson 说：“Pace Industries 一直将员工视为公司最大的资产，我们希望通过这次扩建，可以支持公司的可持续发展，以及帮助员工实现财务独立，提高他们在杰克逊的生活质量。”

田纳西州经济发展部议员 Stuart McWhorter 说，“Pace Industries 公司可以在任何一个工厂进行扩建，但选择了田纳西州，证明田纳西州拥有熟练劳动力和友好商业氛围的优势。杰克逊和麦迪逊县拥有强大的制造业基础，这将是支持 Pace Industries 公司取得成功的沃土。” ■

Expanded Production, Capabilities At Godfrey & Wing

Godfrey&Wing 公司扩大产能

Godfrey & Wing, which manufactures and supplies equipment, sealants, and services to seal porous materials, has expanded vacuum impregnation production capacity at its North American service centers. The focus of this growth is to help manufacturers ensure part performance and build their business

Godfrey&Wing 公司制造并提供设备、密封剂和密封多孔材料提供服务，扩大了其北美服务中心的真空浸渗材料生产能力。这一扩能的重点是帮助制造商保证零件性能，在 2023 年和未来提升盈利能力。

profitability in 2023 and the future.

The expansion results from applying Godfrey & Wing's Production System (GPS) to improve efficiencies and eliminate waste. Production capacity has increased by more than 30% and lowered operating expenses.

The company said it is able to provide new and proven vacuum impregnation solutions for components ranging from die castings to electronics to graphite and EV batteries—which in turn enables them to serve manufacturers that are introducing new materials and product designs requiring vacuum impregnation.

"Our expansion is vital to solving manufacturers' porosity sealing challenges, said Alexander Alford, CEO of Godfrey & Wing. "This allows the best manufacturers worldwide to trust Godfrey & Wing to meet their requirements and the integrity of their bottom line."

Godfrey & Wing's service centers are in Aurora, Toledo, and Defiance, Ohio; Saginaw, Michigan; Milwaukee; and Santa Catarina, Mexico—all geographically positioned to serve the heart of the North American manufacturing industry. ■

本次扩能通过 Godfrey&Wing 公司的生产系统(GPS)来提高效率和减少能耗,产能增加了30%以上,运营费用也有所降低。

该公司表示,它能够为从压铸件到电子产品、石墨和电动汽车电池等部件提供新的、经过验证的真空浸渗解决方案,此外,他们能够为那些引入需要真空浸渗工艺的新材料和产品设计的制造商提供服务。

Godfrey&Wing 公司首席执行官 Alexander Alford 表示:“公司的扩能对解决制造商的孔隙率密封问题至关重要。这使全球顶级制造商能够信任 Godfrey 和 Wing 公司,以满足他们的要求和根本利益。”

Godfrey&Wing 公司的服务中心分布于俄亥俄州的奥罗拉、托莱多和 Defiance, 密歇根州的萨吉诺, 密尔沃基, 以及墨西哥的圣卡塔琳娜, 都处于服务北美制造业中心的地理位置。■

Fisher Barton Builds Turning Center Of Excellence

Fisher Barton 公司打造卓越车削加工中心

AFS Corporate Member Fisher Barton (Waukesha, Wisconsin) held a groundbreaking ceremony March 21 for its new industrial building and site development for its Accurate Specialties' Turning Center of Excellence.

Accurate Specialties, Inc. (ASI) a division of Fisher Barton, is a North American manufacturer of bronze gear blanks for power transmission and agricultural applications. With innovative and integrated manufacturing techniques, it specializes in precision machining, chill casting, centrifugal casting, and spun-cast gear blanks. As a full-service bronze foundry with automated machining capabilities, ASI delivers complete, fully machined, ready-to-hob bronze gear blanks and shafts made to exact customer specifications.

"We are expanding our capacity with this high-speed, fully-automated 56,000 sq.-ft. facility adjacent to our Accurate Specialties division to offer our customers additional manufacturing capabilities for close tolerance components, shafts, and bearings that complement Fisher Barton's already robust offering," said Scott Hoffman, CEO of Fisher Barton. ■

3月21日,美国铸造协会会员企业 Fisher Barton(位于威斯康星州沃科夏)为 Accurate Specialties 卓越车削加工中心其新建厂房和扩展用地举行了奠基仪式。

作为 Fisher Barton 的分公司, Accurate Specialties 公司是一家为动力传输和农业机械提供铜齿轮坯料的北美生产商。凭借创新和一体化的制造技术,公司专业从事精密加工、金属型铸造、离心铸造和离心成型制造齿轮毛坯。作为一家具有全方位自动化机加工能力的青铜铸造厂, Accurate Specialties 公司可以提供完整、全面、随时的加工服务,生产的青铜齿轮毛坯和轴均符合客户的要求。

Fisher Barton 首席执行官 Scott Hoffman 表示:“我们在 Accurate Specialties 分公司附近新建了一个占地 56000 平方英尺(约 5203 平方米)的高速全自动化工厂,将扩大产能,为客户提供紧公差部件、轴和轴承的额外制造能力,扩充 Fisher Barton 公司现已拥有的强大产品阵容。” ■

Thermotec Acquires Pc Campana Mini Riser Division

Thermotec 公司收购 Pc Campana 公司微型冒口业务

THERMOTEC, Inc., a REFCOTEC & Koremart joint-venture, has acquired PC Campana's sand mini-riser division in Lorain, Ohio.

PC Campana has served the metals manufacturing industry with consumable products since 1969. Its mini-riser division was launched in 1984, producing exothermic sand mini risers that could withstand the forces of high-pressure sand molding.

Historically, THERMOTEC's feeding-aid offerings have been limited to vacuum-formed fiber options—the acquisition immediately widens its product offering to include a full line of mini-riser products, which the company says are popular due to their rigidity and superior feeding ability with improved yields.

Mini-riser production will take place at existing THERMOTEC facilities with stringent quality standards and short lead times. ■

THERMOTEC 公司是 REFCOTEC&Koremart 的合资企业,收购了位于俄亥俄州洛兰市的 PC Campana 公司的型微冒口业务。

PC Campana 公司自 1969 年以来一直为金属制造业提供耗材服务,其微冒口部门于 1984 年成立,生产能够承受砂型高压铸造的微型发热冒口。

以前, THERMOTEC 公司的浇口辅助产品仅限于采用真空成型纤维材料。此次收购将扩大其产品范围,包括全系列微型冒口产品,公司表示,这些产品因其刚性和优异的性能以及产量的提升而广受欢迎。

微型冒口将在现有的 THERMOTEC 工厂进行生产,该工厂具有严格的质量标准和较短的交付周期。■

Gm Secures Lithium Source With \$650 Million Investment, Supply Agreement

通用汽车公司签订 6.5 亿美元的锂投资和供应协议

General Motors Co. and Lithium Americas Corp. plan to jointly develop the Thacker Pass mine in Nevada, the largest known source of lithium in the U.S. and the third largest in the world. Under their agreement, GM will make a \$650 million equity investment in Lithium Americas—the largest-ever investment by an automaker to produce battery raw materials.

The Ultium platform is the foundation of GM's EV strategy, including the battery cells, modules, and pack, plus drive units containing electric motors and integrated power electronics. It underpins GM's EV architecture and was developed with a common set of components. Certain vehicles built from the platform will offer battery energy storage options from 50 to more than 200 kWh and driving range of up to 450 miles on a full charge.

Lithium Americas estimates the lithium extracted and processed from the project can support production of up to 1 million EVs per year. Lithium carbonate from Thacker Pass will be used in GM's proprietary

通用汽车公司 (General Motors Co.) 和美洲锂业公司 (Lithium Americas Corp.) 计划联合开发内华达州的 Thacker Pass 锂矿。Thacker Pass 矿是美国已知的最大锂矿,也是世界第三大锂矿。根据他们的合作协议,通用汽车公司将对美洲锂业公司进行 6.5 亿美元的股权投资,这是汽车制造商在电池原材料生产方面有史以来的最大投资。

Ultium 平台是通用汽车公司电动汽车战略的基础,包括电池、模块和电池组,以及包含电动机和集成电力电子设备的驱动单元,是通用汽车公司电动汽车架构的基础,并且由一组通用组件组成。基于该平台制造的车辆将提供 50 至 200kWh 以上的电池储能,续航里程在充满电后可



达 450 英里。

据美洲锂业公司预计，从该项目中提取和加工的锂每年可支持多达 100 万辆电动汽车的生产。来自 Thacker Pass 的碳酸锂将用于通用汽车专用的 Ultium 电池。锂是锂离子电池的关键材料，能够支持重复充电（包括快速充电）和放电，具有更高的能量密度，比其他类型的电池具有更多的可用容量。

通用汽车公司正在推出使用 Ultium 平台生产的一系列产品，包括卡车、SUV、豪华车和轻型商用车，其中有 GMC 悍马

Ultium battery cells. Lithium is a key material in lithium-ion batteries and stands up well to repeated charging and discharging (including enabling fast charging), delivers higher energy density, and offers more usable capacity than other battery types.

GM is launching a broad portfolio of trucks, SUVs, luxury vehicles and light commercial vehicles using the Ultium Platform, including the GMC HUMMER EV Pickup and SUV, GMC Sierra EV, Cadillac LYRIQ, Cadillac CELESTIQ, Chevrolet Silverado EV, Chevrolet Blazer EV, Chevrolet Equinox EV, BrightDrop Zevo 400 and BrightDrop Zevo 600.

“GM has secured all the battery material we need to build more than 1 million EVs annually in North America in 2025 and our future production will increasingly draw from domestic resources like the site in Nevada we’re developing with Lithium Americas,” said GM Chair and CEO Mary Barra. “Direct sourcing critical EV raw materials and components from suppliers in North America and free-trade-agreement countries helps make our supply chain more secure, helps us manage cell costs, and creates jobs.”

Lithium Americas President and CEO Jonathan Evans said, “The agreement with GM is a major milestone in moving Thacker Pass toward production, while setting a foundation for the separation of our U.S. and Argentine businesses. This relationship underscores our commitment to develop a sustainable domestic lithium supply chain for electric vehicles. We are pleased to have GM as our largest investor, and we look forward to working together to accelerate the energy transition while spurring job creation and economic growth in America.”

Production at Thacker Pass is projected to begin in the second half of 2026.

GM has announced four U.S. cell plants with annual capacity of 160 gigawatt hours, including the Ultium Cells joint venture plant with LG Energy Solution in Warren, Ohio, which is in production, and additional JV sites in Spring Hill, Tennessee, and Lansing, Michigan, that are scheduled to open in 2023 and 2024, respectively. The first three Ultium Cells plants are expected to create 6,000 jobs in construction and 5,000 in operations. The automaker is building EVs in two Michigan plants, one Tennessee plant and one Ontario plant, and its suppliers are investing to create a robust North America-focused supply chain for EV raw materials, processed material, and components, with major projects under way in California, Texas, Ohio and Quebec. ■

电动皮卡和 SUV、GMC Sierra 电动汽车、凯迪拉克 LYRIQ、凯迪拉克 CELESTIQ、雪佛兰 Silverado 电动汽车、雪佛兰 Blazer 电动汽车、雪佛兰 Equinox 电动汽车、BrightDrop Zevo 400 和 BrightDrop Zevo 600。

通用汽车公司董事长兼首席执行官 Mary Barra 表示：“通用汽车已经获得了到 2025 年每年在北美地区生产 100 多万辆电动汽车所需的电池材料，公司未来将越来越多地使用国内资源，比如我们与美洲锂业公司合作建立了内华达州工厂。从北美自由贸易协定国家的供应商那里直接采购关键的电动汽车原材料和零部件，有助于保证供应链的安全，帮助公司降低电池成本，创造更多的就业机会。”

美洲锂业公司总裁兼首席执行官 Jonathan Evans 表示，“与通用汽车公司的合作将 Thacker Pass 锂矿业务推向一个重要里程碑，同时为公司的美国和阿根廷业务分离奠定了基础。这种关系突显了我们对国内电动汽车锂供应链走可持续发展的承诺。我们很高兴通用汽车公司成为公司最大的投资者，我们期待通过双方的合作，加快能源转型，同时促进创造就业机会和激励经济增长。”

Thacker Pass 锂矿的生产预计将于 2026 年下半年开始。通用汽车公司宣布了 4 家年产能为 160 千兆瓦时的电池工厂，包括位于俄亥俄州沃伦已投产的与 LG 能源解决方案的 Ultium Cells 合资工厂，以及计划分别于 2023 年和 2024 年在田纳西州斯普林希尔和密歇根州兰辛开设的其他合资工厂。首批三家 Ultium Cells 工厂的建设预计将增加 6000 个就业机会，在运营中创造 5000 个就业机会。通用汽车公司正在密歇根州的两个工厂、一个田纳西州工厂和一个安大略省的工厂生产电动汽车，其供应商正在建设一个以北美为核心的强大的电动汽车原材料、加工材料和零部件供应链，主要项目位于加利福尼亚州、得克萨斯州、俄亥俄州和魁北克。■



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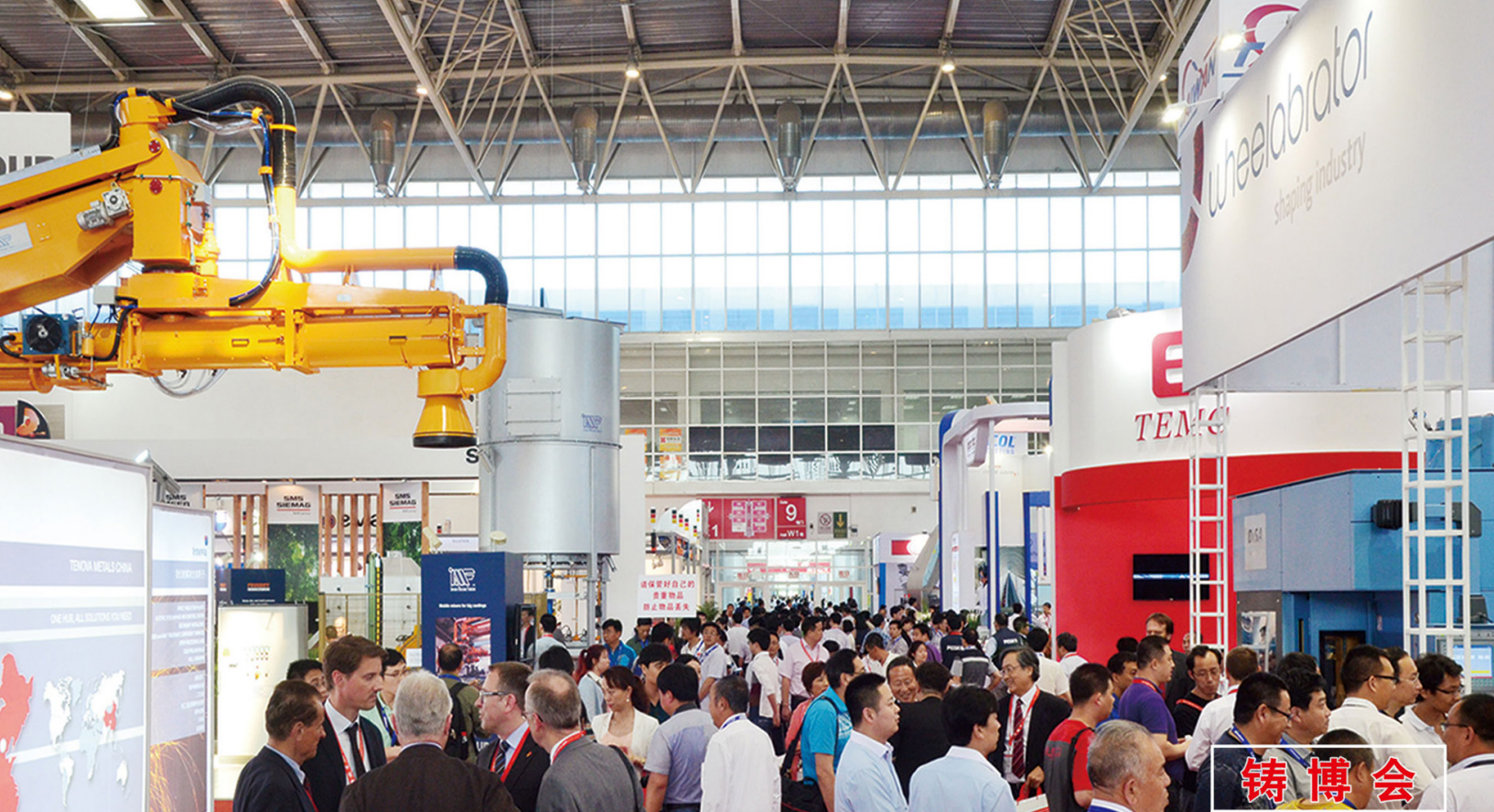
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中国铸造协会官方微信平台



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Confidence, Opportunity, Win-win: METAL CHINA 2023 is Ready

信心 机遇 共赢——第二十一届中国国际 铸造博览会蓄势待发

Initiated in 1987, China International Foundry Expo (METAL CHINA) is sponsored by China Foundry Association. It is authoritative, representative, forward-looking and industry-oriented, and is known as the vane of China's foundry industry.

The 21st China International Foundry Expo (METAL CHINA 2023) will be held from May 8-11, 2023 in the National Convention and Exhibition Center (Tianjin). With the goal of high-quality development and the guidance of meeting the development needs of the industry, Metal China has evaluated the situation and returned to Northern China after four years. With Tianjin, an important gateway and advanced manufacturing research and development base in Northern China as the platform, the fair will radiate to the whole areas of China and create a grand event of the foundry industry with "smooth double circulation, enabling new development and achieving new growth". The exhibition

始创于 1987 年的中国国际铸造博览会，是中国铸造协会主办，得到铸造企业及上下游行业的积极响应和大力支持，独具权威性、代表性、前瞻性和导向性，被誉为中国铸造业发展的风向标。

秉承为行业服务的初心和理念，“第二十一届中国国际铸造博览会”将于 2023 年 5 月 8-11 日在国家会展中心（天津）起航，打造一个“畅通双循环、赋能新发展、实现新增长”的国际铸造行业盛会。铸博会将以崭新的面貌和激情的活力，加速推动行业向着高端、智能、绿色持续发展，届时将吸引国内外知名展商与超 10 万人次的专业观众，汇集来自全球的铸造新技术、新产品及海量的采购订单，为业内交流、供需提供宽广舞台和高端视角，加速推进全国铸造产业结构布局，助力中国铸造高质量协同发展。

全球铸造行业盛会 GLOBAL FOUNDRY EVENT



also opens a new stage in the changing situation, showing the achievements of continuous innovation and development of China Foundry Industry.

With an exhibition area of nearly 100,000 square meters covering 6 theme exhibition halls, and more than 100 wonderful industry activities, the exhibition will attract nearly 1000 well-known exhibitors from around 30 countries and regions, and nearly 100,000 onsite visitors to the show. It will once again become an important platform to promote the transformation and upgrading of the foundry industry and take the high-quality development road.

A strong lineup of the entire industry chain

The exhibition focuses on high-quality castings, casting equipment, casting materials, automation supporting and surrounding equipment, environmental protection equipment, etc. The exhibits also include the upstream and downstream industries such as machine tools, auto parts, construction machinery, agricultural machinery, general machinery, internal combustion engine, rail transit, petroleum and petrochemical industries. With hardware products and also software products, it will become an exclusive business platform for enterprises to showcase their brands and obtain targeted procurement resources.

Special exhibition areas, new products display, smart solutions bloom

At present, the foundry industry is rapidly moving towards innovation, intelligence, and green. The demand for lightweight automobiles is increasing significantly, integrated die-casting, and 3D printing greatly transform the traditional foundry process...The exhibition featured with industry hot topics, all kinds of solutions and products will bloom at the exhibition.

METAL CHINA is a one-stop platform to purchase casting, material and equipment, as well as a perfect occasion to obtain industry and marketing information, interact with industry leaders and experts. World focus, worth waiting.

For more information, please visit : www.expochina.cn

本届展会展览面积近 10 万平米，6 大主题展馆、配套百余场精彩行业活动，将吸引来自 30 多个国家和地区的近 1000 家知名展商和 10 万人次线下专业观众共襄盛会，将再次成为推动铸造行业转型升级、走高质量发展道路的重要平台。

全产业链强大阵容

本届展会将集中展示铸造行业的优质铸件、铸造设备、铸造材料、自动化配套及周边设备、环保设备等，内容同时辐射机床、汽车零部件、工程机械、农机、通用机械、内燃机、轨道交通、石油石化等上下游行业，涵盖多个行业细分领域。不仅有硬件产品，也有软件产品，将成为行业企业风采展示并获得定向采购资源的专属商贸平台。

特色展区、新品汇聚、智能解决方案大放异彩

当前，铸造业正朝着创新、智能、绿色方向快速前进，汽车轻量化需求大、一体化压铸、3D 打印让铸造焕发青春……围绕行业领域热点话题和共性难点“多点开花”的特色展区将在展会上大放异彩。

METAL CHINA 是一个集铸件、材料和设备展示及采购的一站式平台，是获取行业和市场信息、与行业领导者和专家互动的绝佳机会。全球聚焦、值得期待！

更多展会信息，请访问网站：www.expochina.cn



Implementation of Casting Simulation for Increased Engine Performance and Reduced Development Time and Costs – Selected Examples from FORD R&D Engine Projects

通过铸造模拟来实现发动机性能的提升以及开发时间和成本的降低——福特发动机 R&D 项目

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Abstract

The application of CAE is continually gaining in importance in all areas of engine development. This is especially true for the simulation of the casting process as well as for the following heat treatment. Although the durability analysis of the finished component has long been an established part of the development process, CAE-technologies for the simulation of the manufacturing process have only recently come into focus.

The advantages of simulation at an early stage are obvious. Only by using the simulation of the manufacturing process is it possible to determine the distribution of inhomogeneous mechanical properties (hardness, elongation and yield strength) as well as residual stresses and to consider these properties in the design optimization process, especially in FEM calculations. The quality of the CAE analysis is significantly improved, therefore the full potential of the cast material can be taken advantage of in early design stages. On the other hand, through the optimization of heat treatment using simulation, the performance of the engine can, for example, be increased without cost-intensive design changes within the existing design concept.

In this paper the involved companies, using selected examples from continuing R&D projects, will illustrate the potential to reduce the development time while simultaneously increasing the quality of the component. The methodology of simulating the casting process has been integrated as a key technology into the development process of cylinder heads and blocks at Ford Motor Company and has led to a

摘要：

在发动机开发的各领域，CAE 的应用日益重要。特别是对于铸造工艺以及随后的热处理模拟尤其如此。虽然成品部件的耐用性分析长期以来一直是开发过程的一部分，但用于模拟制造过程的 CAE 技术直到最近才成为焦点。

早期模拟的优势非常明显，只有通过制造过程的模拟，才能确定非均匀的力学性能（硬度、延伸率和屈服强度）以及残余应力的分布，并在设计优化过程中考虑这些性能，特别是在 FEM 计算中，CAE 分析的质量有了显著的提高，因此可以在早期设计阶段充分利用铸造材料的潜力。另一方面，通过模拟对热处理工艺进行优化，例如，在现有的设计概念中，不需要进行成本密集型的设计变更，就可以提高发动机的性能。

在本文中，相关公司将利用持续研发项目中的部分案例，说明在减少开发时间的同时提高产品质量的潜力。铸造工艺的模拟已作为福特汽车公司气缸盖和缸体开发过程中的关键技术集成，并显著降低了开发时间和成本。

1. 介绍：发动机开发的要求

过去的 3-5 年中，发动机的开发经历了快速发展过程，改善最显著的部分是重量、空间设计和性能；对比 10 年前，这些特性以前所未有的开发速度得到了提高（图 1）。根据开发目标，发动机在投入生产时进行了以下改进：

significant reduction in development times and costs.

1. Introduction - Requirements for Engine Development

Engine development has undergone a tremendous development process in the last three to five years. The cornerstones of this development are weight, design space and performance; features that have been enhanced with a development rate that has not been experienced in the decade before (Fig. 1). Depending on the development goal, engines went into production with the following improvements:

- performance increase by 50% with same total weight, or
- reduction of engine weight and design space by 25% with same performance.

The customer highly appreciates and honors these improvements, where especially resulting features like reduced gasoline consumption, crash security, and the overall driving fun deliver high customer value. The next development goals are gasoline engines with 90 kW/L, 140 bar, and diesel engines with 80 kW/L, 200 bar, respectively. With this 'quantum leap' in engine development, companies are forced to break new ground in many areas. However, these ambitious goals can not be met with common procedures. New processes and methods are required to successfully enter new territory.

2. Future Development Process

The general development targets have not really changed:
-Reducing development times
-Exploiting the potential of design and material
-Reducing costs in the development process
-Reducing component costs and production costs

The approach to support physical component tests with numerical processes has successfully been used before and led to an extensive use of CAE in today's engine development process:

- Structural analysis (durability, acoustics/ NVH)
- Flow simulation (intake/exhaust gas system, in-cylinder flow, simulation of oil circulation and water jacket, crank case/ PCV system)
- Dynamics of multibody systems (valve train, timing gear, crankshaft, piston)
- Simulation of friction and wear, bearing calculation

The individual CAE methods have reached such a quality and accuracy level that aspects like production

- 当总重量相同时，性能提高了 50%，或
- 性能相同，发动机重量和空间设计减少 25%。

客户非常赞赏和尊重这些改进，特别是由此产生的效应，如减少油耗，提升碰撞的安全性和整体驾驶乐趣，带来了很高的客户价值。下一个发展目标分别是 90kW/L、140 bar 的汽油发动机和 80kW/L、200 bar 的柴油发动机。随着发动机开发的“重大突破”，公司不得不在许多领域开辟新的道路，然而，这些雄心勃勃的目标不能通过常规的流程来实现，成功进入新的领域需要新的工艺和方法。

2. 未来的开发工艺

总的开发目标一如既往：

- 减少开发时间
- 提升设计和材料的潜能
- 降低工艺开发的成本
- 降低零部件成本和生产成本

用数值过程支撑零部件物理的测试方法在以前已经成功地使用过，并使得如今 CAE 在发动机开发过程中广泛使用：

- 结构分析（耐久性、声学 / NVH）
- 流量模拟（进 / 排气系统、缸内流量、油循环和水套模拟、曲轴箱 /pcv 系统）
- 多体系统动力学（气门机构、正时齿轮、曲轴、活塞）
- 摩擦和磨损模拟，承载力计算

独立的 CAE 方法已经达到了一定的质量和精度水平，在生产、公差和生产中的参数变化等方面的影响越来越大。

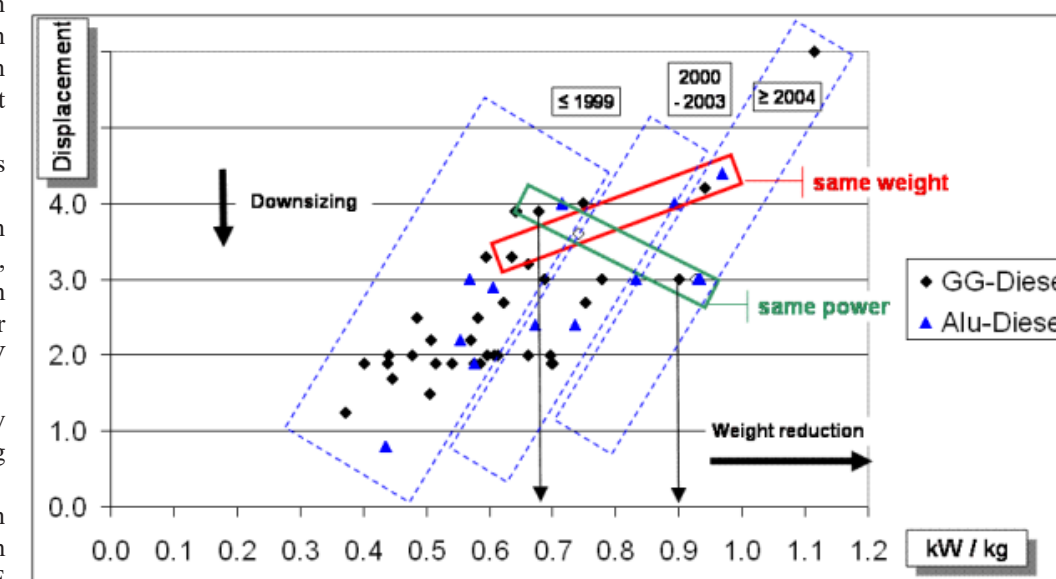


Figure 1: Development trends regarding specific power output and displacement
图 1：比功率输出和排量的发展趋势

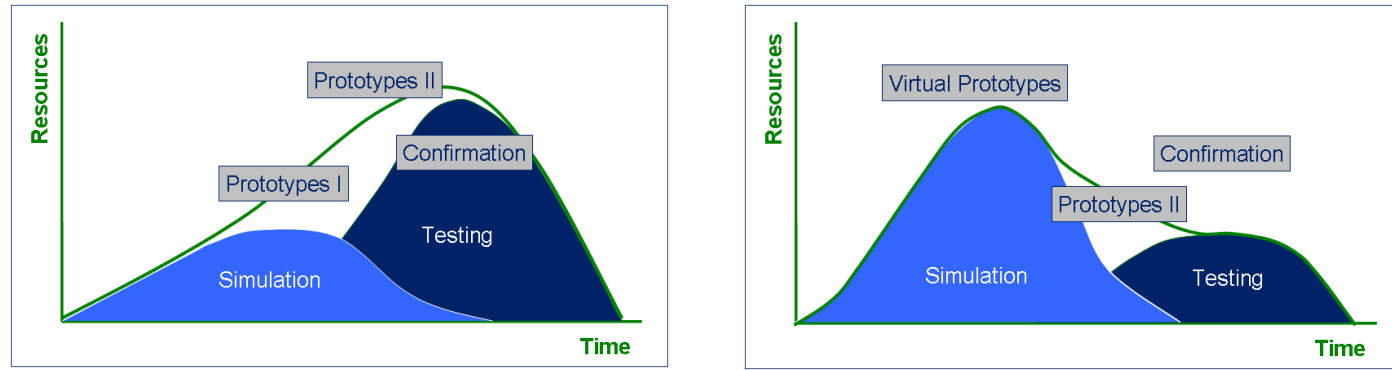


Figure 2: Resource shift following the Integrated CAE Development Process
图 2：集成 CAE 开发工艺后的要素变化

influences, tolerances, and parameter variation in production have increasingly more impact. Consequently, current CAE developments are mainly focused on production processes:

- Failure hypotheses - considering local properties (microstructure, material defects, inhomogeneities) and more accurate material data (chemical composition, elevated temperatures)

- Manufacturing simulation - casting, forging, heat treatment, machining, joining etc.

This is the basis for the future development process: not only further development but integration of CAE methods, i.e. a complete and Closed Loop CAE Procedure for the simultaneous optimization of component and production process. This is the only way to reach the required quality level in the development process to achieve zero prototyping, substantially reducing development time as well as development costs (Fig.2). At the same time, the Closed Loop CAE Procedure together with the resulting improved analysis quality is the prerequisite to develop next generation high performance components.

因此，目前的 CAE 的发展主要集中在生产过程中：

- 失效假设 - 考虑局部特性（显微结构、材料缺陷、不均匀性）和更准确的材料数据（化学成分、高温）

- 制造模拟 - 铸造、锻造、热处理、机加工、焊接等。

这是未来开发过程的基础：不仅是巩固和提高，而是 CAE 方法的整合，即完整的闭环 CAE 流程，用于同时优化零部件和生产过程，这是在开发过程中达到所需的质量水平唯一途径，以实现零样件，从而大大减少了开发时间和开发成本（图 2）。同时，闭环 CAE 流程以及由此产生的改进的分析质量是开发下一代高性能零部件的先决条件。

3. 铸造工艺模拟可以优化开发过程

发动机部件零样件开发过程的重要部分是模拟铸造过程和热处理是否适用（图 3）。目的是确定材料性能的不均匀分布、残余应力、零部件设计的影响、工艺参数及其

3. Casting Process Simulation for the Optimization of the Development Process

An important part of the zero prototyping development process for engine components is the simulation of casting processes and heat treatment if applicable (Fig.3). The objective is to identify the inhomogeneous distribution of material properties, residual stresses, the influence of component design, process parameters and their variations, and last but not least the influence of the cast alloy. The simulation of the complete casting process provides results like.

- Hardness (required optimization parameter regarding the machining of iron castings that are of increasingly lightweight structure)

- Yield limit, tensile strength, SDAS, and further microstructural characteristics (important parameters for the component behavior under load as well as for failure life calculations)

- Porosities (influence on function and fatigue life)

Residual stresses are computed by simulating the casting or heat treatment process and are being implemented in the fatigue calculation as 'pre-load of the component'.

The casting process simulation is easily integrated into the conventional CAE procedure. Due to the parallel integration the development process is not prolonged in spite of the significant quality improvements (Fig.4).

4. FORD Engine Development - Examples

The potential of casting simulations covers all iron and nonferrous alloys as well as all casting processes. Foundries use casting simulation on a regular basis for the optimization of casting technology and production parameters. The objective is to avoid cold laps, porosities and inclusions, and in the case of cast iron components also to analyze the microstructure for the calculation of hardness and yield point. The main parameter for CGI (compacted graphite iron) is nodularity (Fig.5).

Affected by the design, some areas cool down much faster than others leading to locally increased hardness values in cast iron (Fig.6). The simulation identifies this problem making it possible to respond as early as in the virtual development phase. Additionally, because of the high sensitivity of the MAGMA simulation it is possible to calculate the influence of alloy modifications even in the range

变化，以及最后且重要的，铸造合金的影响。整个铸造工艺的模拟的结果如下：

- 硬度(关于轻量化结构的铸铁件加工所需的优化参数)
- 屈服极限、抗拉强度、SDAS 和进一步的微观结构特性（载荷下零件状态以及失效寿命计算的重要参数）

- 孔隙率（对功能和疲劳寿命的影响）

通过模拟铸造或热处理工艺来计算残余应力，并在疲劳计算中作为“零件的预载荷”来实现。

铸造工艺模拟很容易集成到传统的 CAE 程序中。由于并行集成，质量有了显著的改进，而且开发过程并没有延长（图 4）。

4. 福特发动机的研发

铸造模拟的潜力涵盖黑色和有色合金以及所有铸造工艺。铸造厂定期采用铸造模拟的方法来优化铸造工艺和生产参数，目的是避免冷隔、缩孔和夹杂物，在铸件中，也需要分析微观结构，从而计算硬度和屈服点。CGI（蠕墨铸铁）主要关注的参数是球化率（图 5）。

受工艺设计的影响，某些区域比其他区域冷却得快得多，导致铸铁硬度值增加（图 6）。模拟验证了这个问题，使其能够早在虚拟开发阶段就采取措施。此外，由于 MAGMA 模拟的高灵敏度，即使在工艺变化的范围内，也可以计算出合金变化的影响。因此，考虑到局部增加的硬度值，通过闭环 CAE 程序来确定最佳的合金方案。

此外，不均匀的冷却速率会导致力学性能不一致（图

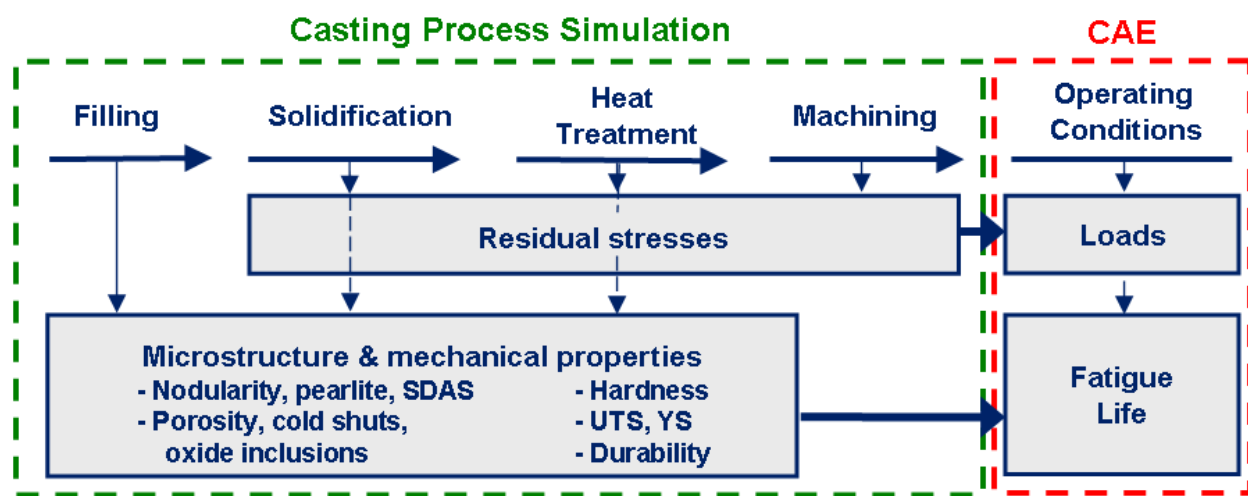


Figure 3: Impact of casting and manufacturing processes on the component performance
图 3：铸造和制造工艺对零部件性能的影响

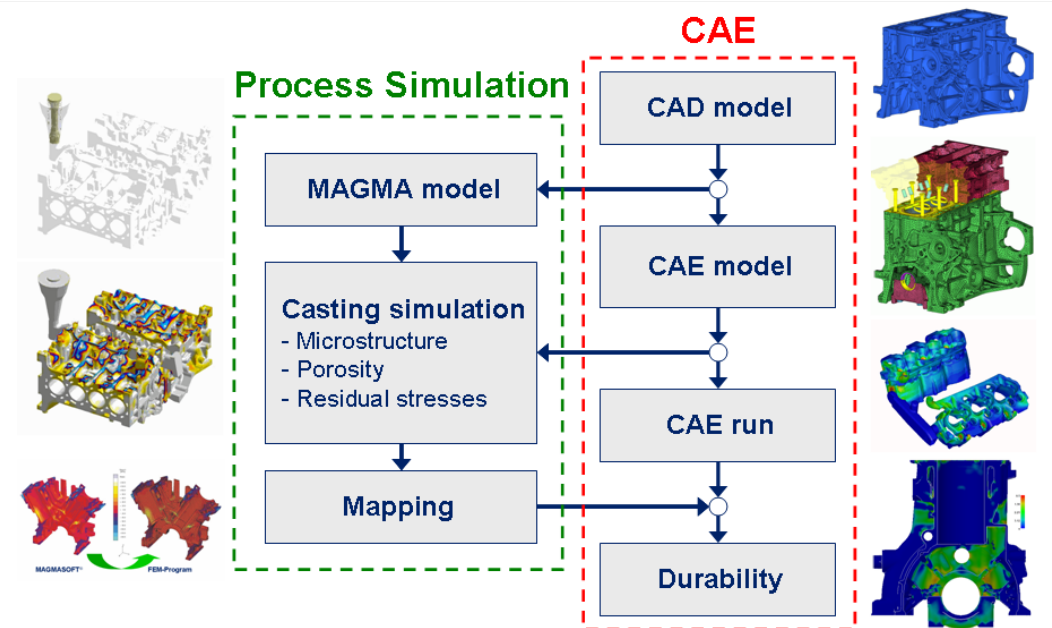


Figure 4: Integration of CAE and casting simulation
图 4：CAE 与铸造模拟的集成

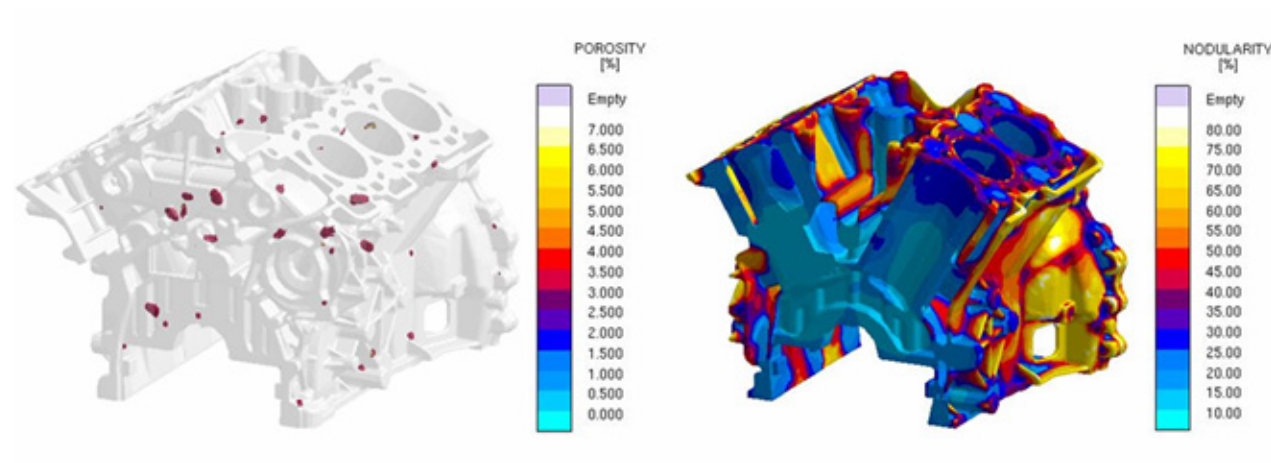


Figure 5: Porosity and nodularity distribution (section) in a CGI block
图 5：螺墨铸铁缸体孔隙率和球化率分布（部分）

of process variations. Consequently, the Closed Loop CAE Procedure is the way to identify the optimal alloy considering the locally increased hardness values.

What is more, inhomogeneous cooling rates cause inhomogeneous mechanical properties (Fig.7) that cannot be neglected in the new generation of high performance components and hence need to be considered in the Closed Loop CAE Procedure. The challenge is to combine production simulation and failure life calculations in an integrated CAE tool.

The zero prototyping development process adds the calculation and integration of residual stresses to the simulations that are traditionally rather foundry-relevant. The residual stresses in engine blocks are often as high as the assembly and operating loads themselves. However, the formation of residual stresses follows completely different principles than the formation of thermal and mechanical operating stresses. Consequently, superposing these stresses does not only lead to increased stresses but also to compensations, with the according impact on fatigue life.

7), 这在新一代高性能零部件中是不能忽视的, 因此需要在闭环 CAE 流程中加以考虑。挑战在于将生产模拟和失效寿命的计算结合在一个综合的 CAE 工具中。

零样件开发过程将残余应力的计算和集成添加到传统的与铸造相关的模拟中。发动机缸体中的残余应力通常与装配和操作负载本身一样高, 然而, 残余应力的形成与热应力和机械应力的形成的原理完全不同。因此, 叠加这些应力不仅会导致应力的增加, 也会相互抵消, 并对疲劳寿命产生相应的影响。

集成 CAE 程序将残余应力作为第四载荷, 与三种传统载荷: 装配、温度和峰值压力之间的重要性相同, 在失效寿命计算中考虑了局部力学性能 (图 9)。

稍加修改后, 该程序也用于气缸盖和其他热处理零部件, 由于零部件中存在明显的温差, 主要在淬火过程中产生残余应力 (图 10)。模拟考虑了淬火介质中的传热和由此产生的冷却效应。

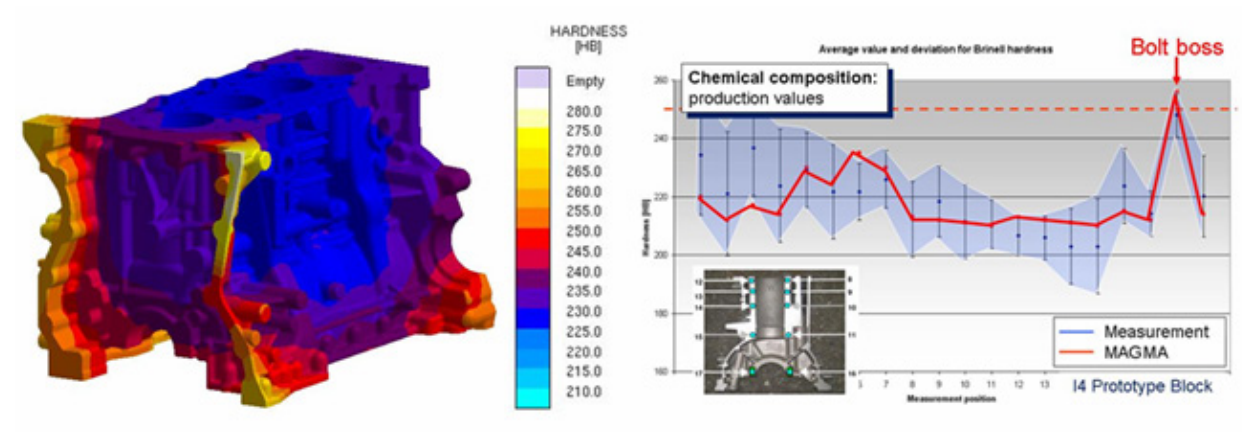


Figure 6: Hardness distribution and simulation sensitivity for GJL
图 6：硬度分布和模拟灵敏度

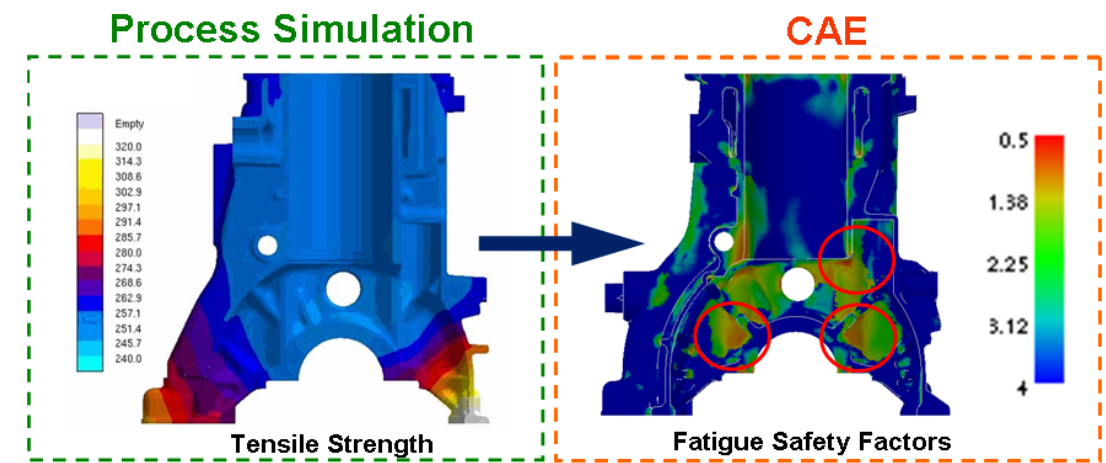


Figure 7: Local mechanical properties and fatigue safety factor prediction
图 7：局部力学性能和疲劳安全系数的预测

The integrated CAE procedure includes residual stresses as the fourth load case with the same importance as the three traditional load cases assembly, temperature, and peak pressure. The local mechanical properties are considered in the failure life calculations (Fig.9).

Slightly modified, this procedure is also used for cylinder heads and other heat treated components, where the dominant residual stresses are created during the quenching process due to the significant temperature differences in the component (Fig.10). The simulation considers the heat transfer in the quenching medium and the resulting cooling behavior.

Residual stresses in high-strength heat treated cylinder heads are in some cases so close to failure limit that prototype failure can already be explained with a simple residual stress analysis. (Fig.11). Thus, also for the consideration of heat treatment in the development process of high performance components, the integrated CAE procedure is indispensable.

Aluminum cylinder blocks with gray cast iron inserts

高强度热处理气缸盖中的残余应力在某些情况下非常接近失效极限, 以至于用简单的残余应力分析已经可以解释原型失效 (图 11)。因此, 在高性能零部件的开发过程中考虑热处理, 集成 CAE 程序是必不可少的。

带有灰铸铁缸套的铝合金气缸体也有类似的情况, 缸筒壁残余应力是加工过程中开裂的原因, 在生产开发过程中, 可以采取适当的措施来解决缸筒壁开裂。然而, 残余应力仍将存在于零件中, 并将对这些未来高性能发动机的疲劳寿命产生影响 (图 12)。因此, 集成的 CAE 程序对于开发高应力铝合金发动机部件至关重要, 无论它们是否经过热处理。在处理混合零部件时尤其如此。

另一个主题是使用虚拟实验设计开发新技术。带铸铁缸套的铝合金缸体的稳健设计需要解决以下任务:

- 衬套以及缸筒壁的最佳壁厚比
- 控制型腔或者高压模具中衬套的预热。

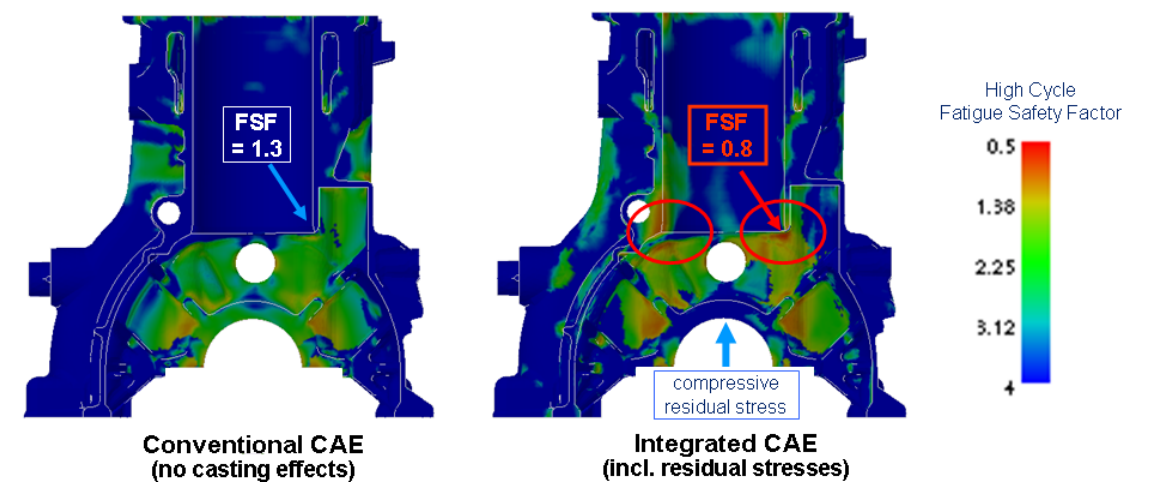


Figure 8: Impact of residual stresses on failure life prediction
图 8：残余应力对失效寿命预测的影响

show a similar picture. The residual stresses in the cylinder bridges are the reason for bridge cracks during machining. The appropriate actions to address the bridge cracks can be taken during the production process development. However, residual stresses will still be present in the component and will have an impact on the fatigue life of these future high performance engines (Fig.12). Consequently the integrated CAE procedure is essential for the development of highly stressed aluminum engine components, whether they are heat treated or not. This is especially true when dealing with hybrid components.

Another topic is the use of a virtual DoE (Design of Experiment) for the development of new technologies. The robust design of aluminum crank cases with cast iron cylinder liner inserts requires e.g. to address the following tasks:

- Optimum wall thickness ratio of liner and bore bridge
- Controlled preheating of the liners in the core package or a high pressure die casting die.
- Using the appropriate casting parameters to avoid cold laps
- Securing optimum heat transfer at operating temperature with the aluminum shrink-on process
- Ensure sealed bond between liner and aluminum structure

Compared with the 'conventional' process that includes various process steps like design, trial castings, analysis of prototypes, engine tests, and pulser tests, including the necessary optimization loops covering the whole process, the new Closed Loop CAE Procedure is much quicker and more efficient:

- Designing geometry for minimum wall thicknesses
- Strength calculation and casting simulation

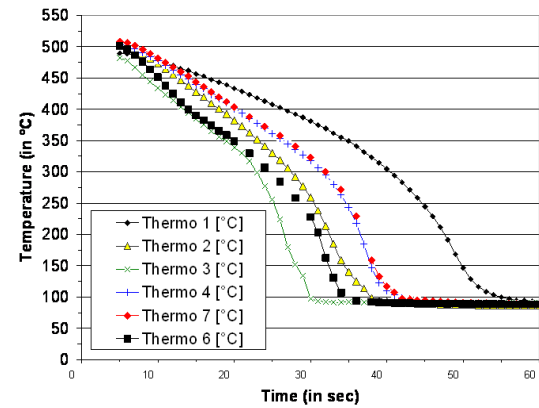


Figure 10: Cooling curves and temperatures in a cylinder head during water quench
图 10: 水冷淬火, 气缸盖内的冷却曲线和温度

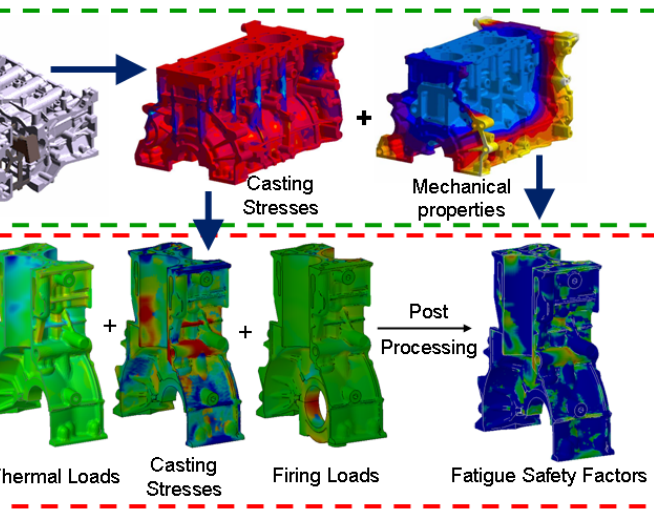


Figure 9: Integrated CAE procedure
图 9: 集成 CAE 程序

- 使用适当的铸造参数, 以避免冷隔
 - 在铝合金收缩过程中在一定操作温度下确保最佳的热传导
 - 确保衬套与铝合金结构之间的密封结合
 - 与包括设计、试铸、原型分析、发动机测试和脉冲测试等各种工艺步骤的“传统”过程相比, 包括覆盖整个过程的必要优化循环, 新的闭环 CAE 程序更快、更高效:
 - 最小壁厚的几何形状设计
 - 强度计算及铸造模拟
 - 通过反复计算强度、铸件性能和残余应力的优化循环
 - 生产原型样品
 - 在发动机试验和脉冲发生器试验中验证设计
- 铸造模拟不仅提供了设计和工艺布局的所有相关信息 (图 13), 还可以使用虚拟 DOE 分析参数的相关性, 从

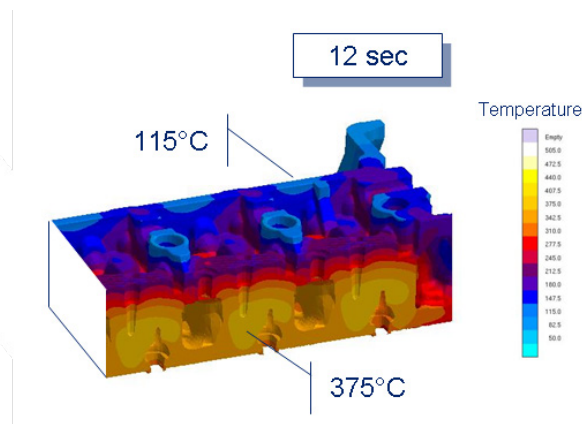


Figure 11: Test result and virtual residual stress analysis of a prototype cylinder head
图 11: 原型气缸盖的试验结果及虚拟残余应力分析

- Optimization loops with repeated calculation of strength, casting properties, and residual stresses
- Producing prototype components
- Verifying design in engine trials and pulser tests

Casting simulation does not only deliver all relevant information for the layout of design and process (Fig.13); it now represents a powerful and robust feature that allows the use of a virtual DoE to analyze the interdependencies of its parameters. Not only the significantly reduced development times and costs, but also and especially the extended gained knowledge regarding component load capacity as well as process sensitivity can be seen as important advantages providing a considerably improved basis for future developments.

5. Potential for the Development Process

The previous chapter demonstrates the integrated CAE procedure as a powerful and effective tool to reduce development time and costs as well as to optimize quality. This applies to new technology concepts as well as to product development.

而确保产品的稳健性。不仅显著减少了开发时间和成本, 特别是扩展了关于零件负荷能力和过程敏感性的知识, 这一重要的优势, 为未来的发展提供了相应改进的基础。

5. 开发过程的潜力

上一章介绍了集成的 CAE 程序作为强大和有效的工具, 可以减少开发时间和成本, 并优化质量。这也适用于新的技术概念和产品的开发。

在质量改进和节省成本方面的主要潜力包括: 铸造试验 (充型、凝固、冷隔、缩孔)、样品生产、零部件和材料分析 (残余应力、性能)、包括结果评估、加工试验 (硬度、裂纹), 最后, 同样重要的是可靠的生产参数 (铸造参数、合金、嵌件温度) 的定义。

5.1. 以最小的努力开发新技术

作为新技术开发的一部分, 集成的 CAE 程序使高级设计阶段的概念研究具有显著的优势。过去, 这应用于铸

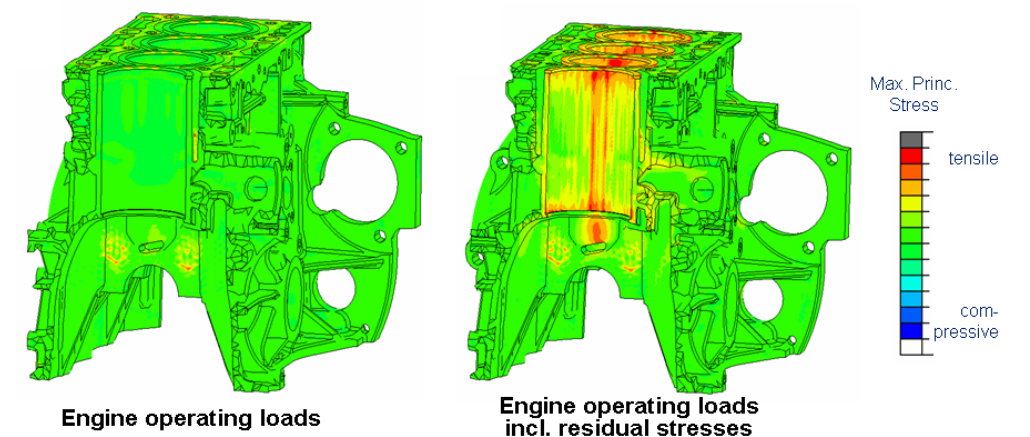


Figure 12: Impact of residual stresses on total stresses during engine operation
图 12: 发动机运行过程中残余应力对总应力的影响

The main potentials for quality improvements and cost savings are: casting trials (filling, solidification, cold laps, porosities), prototype manufacturing, component and material analyses (residual stresses, properties), test runs including result evaluation, machining trials (hardness, cracks), and last but not least the definition of robust production parameters (casting parameters, alloys, insert temperatures).

5.1. Developing New Technologies With Minimum Effort

The integrated CAE procedure provides significant advantage in the advanced design phase for concept studies as part of the development of new technologies. In the past, this applied to the development of iron inserts, alternative heat treatment processes, or material substitutions. In the future, targets are more widespread topics, starting from thin wall castings via machining clamp loads and die lifetime up to alloy development.

The saving potential is explained in the complete substitution of the experimental DoE with a virtual DoE. In the advanced design phase the time for technology development can be reduced down to 50% - 25% of the normal time and costs can be reduced by up to 50 % due to omitting extensive work for sample production and machining, for tests, and for component checks.

The distinctive feature of the virtual DoE is the ability to address bigger development steps regarding design, material, and process, which is due to the fact that a much higher number of parameters can be considered including the influence of their interdependencies.

5.2. Reducing Engine Product Development Times and Costs

The first step to introduce the integrated CAE procedure into product development is the consequent parallelization of component CAE and manufacturing simulation. This measure already reduces the development time by ca.3 months, as the development of casting prototypes can be finished in time with the last design step. The increased effort for simulation and coordination during the simultaneous optimization creates additional costs; however, these costs are more than compensated by the early consideration of production related influences and the reduced effort for test bed runs. Further development focuses on the completion of material data and models for

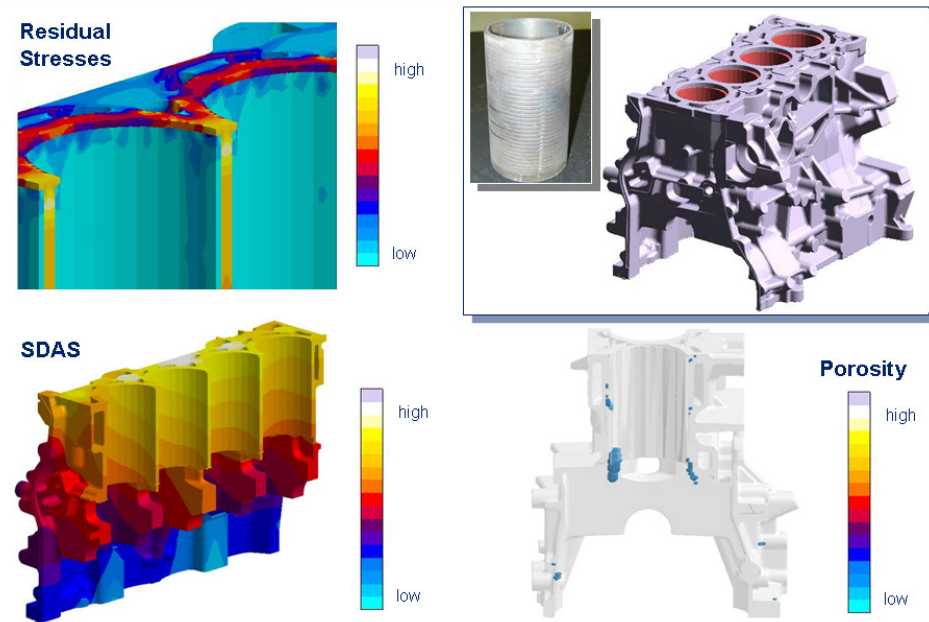


Figure 13: Casting simulation supporting new technologies
图 13：铸造模拟支持新技术

铁镶嵌件，替代的热处理工艺，或材料替代的发展。在未来，目标是能应用的更广泛，从薄壁铸件开始，通过机加载荷和模具寿命到合金的发展。

用虚拟实验设计完全替代实际实验设计，有效的节约了资源。在高级设计阶段，技术开发的时间可以减少到正常时间的 50% - 25%，成本可以减少高达 50%，因为不用做样品的生产和加工、测试和零部件检查的工作。

由于可以考虑更多的参数，包括它们相关性的影响，虚拟实验设计的特点在于能够处理涵盖有关设计、材料和过程的更广的开发步骤。

5.2. 减少发动机产品的开发时间和成本

将集成的 CAE 程序引入产品开发的第一步是零部件 CAE 与制造模拟的并行化。由于铸造原型的开发与最后一步设计可以及时完成，该措施已经减少了 3 个月的开发时间。在同步优化过程中增加的模拟和协调工作产生了额外的成本，然而，由于早期考虑了影响生产的因素，并且减少实验测试，这些成本可以得到补偿，进一步的发展重点是对应用材料范围的材料数据和模型进行完善。

第二步是在系列 1 阶段中使用虚拟样机完全取代物理样机及其相关的实验平台（图 14）。其结果是，发动机开发时间减少了约 6 个月，以及相应的成本降低，协同效应会对包括发动机加工在内的几个工艺步骤产生影响。这里的挑战是将核心工程资源转移到 CAE 评估上。

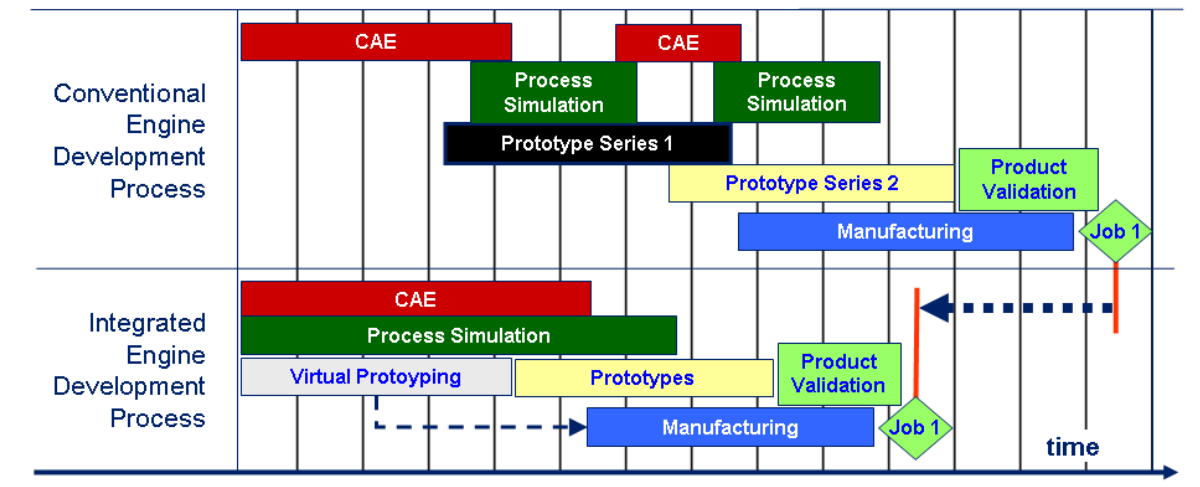


Figure 14: Savings in development time due to integrated CAE processes
图 14：集成的 CAE 程序节省了开发时间

the whole range of applied materials.

The second step is the total substitution of the physical prototypes and their related test bed runs with virtual prototypes in the series-1-phase (Fig.14). The result is the reduction of engine development time by approximately 6 months as well as the corresponding cost reduction with synergy effects having impacts on several process steps including engine machining. The challenge here is shifting the core engineering resources towards CAE evaluation.

6. Conclusion

The comprehensive integration of manufacturing process simulation into the engine CAE development procedure (Fig. 15) is the key to success for the accelerated realization of engine downsizing and increased performance that comes along with a reduction in development time and costs at the same time. It is the prerequisite for zero prototyping.

Our examples show the tremendous opportunities in the integrated CAE procedure, exceeding by far the savings achieved by the general and more traditional approaches. The result of this concept is like a 'breakthrough' that has rarely happened before in engine development and that will prove to be a cornerstone for all future developments.

6. 结论

将制造过程模拟全面集成到发动机 CAE 开发过程中（图 15）是成功加速实现发动机尺寸缩小和提高性能的关键，同时也减少了开发时间和成本。这是零样件的先决条件。

我们的例子显示了在集成 CAE 程序中存在巨大的机会，远远超过了一般和更传统的方法所节省的费用。这一概念就像一个“突破”，这在发动机发展中是很少发生的，这将被证明是所有未来发展的基石。

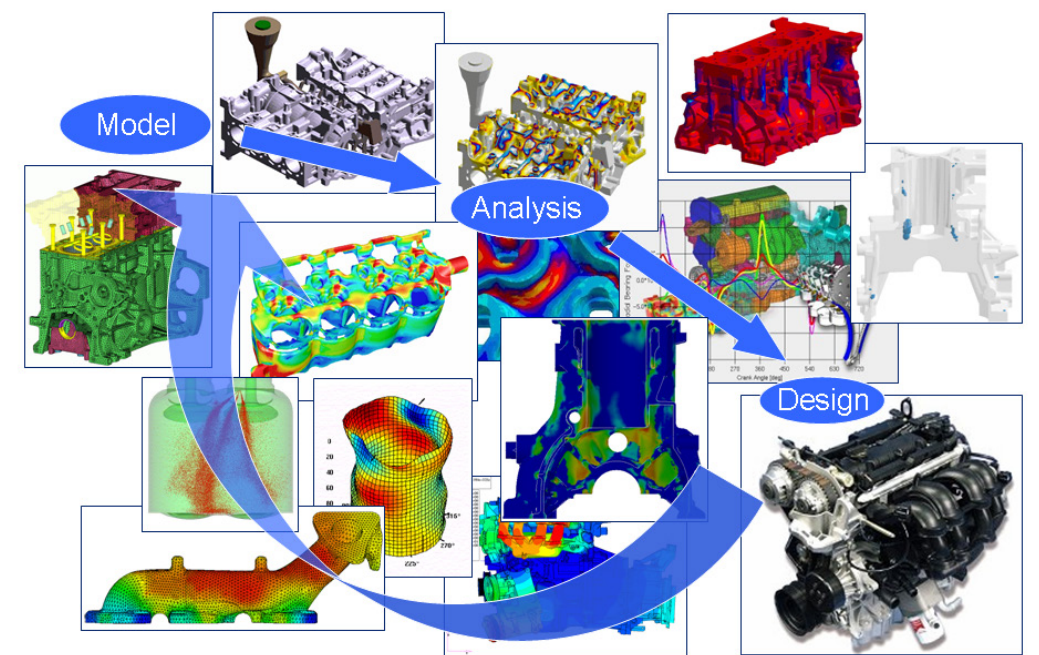


Figure 15: Integrated CAE process applied to engine development
图 15：集成 CAE 程序应用于发动机的开发

Us Industry Outlook 2023: Sales Expected To Keep Growing

Report by Modern Casting

2023 年美国铸造行业展望： 销售额有望继续攀升

Modern Casting 报道

While most foundries expect a recession in 2023, steady orders and full order books lead to optimism among metalcasters.

U.S. casting sales saw a second strong year of growth in 2022. After a dip in sales in 2020 that brought overall industry revenue to \$36.7 billion (down from \$44.2 billion), the U.S. foundry industry reached \$43.3 billion in casting sales in 2021 and \$46.3 billion in 2022.

AFS forecasts another year of growth in 2023, albeit somewhat tempered from the pandemic recovery years of 2021 and 2022. Overall estimated revenue for 2023 is \$48.3 billion, according to the 2023 AFS Metalcasting Forecast & Trends. This is a 4.3% increase over 2022. In 2022, operating expenses were 82.8% of revenue for foundries, with total operating expenses growing 12.1% year over year.

Foundry operating expenses break down as follows: 51.5% for cost of materials, 32.8% employee expenses, 7.3% buildings and expenses and 8.9% other expenses. According to the report, an estimated 89% of foundries are profitable, with an average net income of 9.2% of revenues. The number of U.S. facilities (excluding art and educational foundries) is estimated to be 1,715. Revenue per facility from 2021 to 2022 increased by 10.1% and a 4.6% growth is expected into 2023. Estimated annual revenue per facility is forecast to reach \$33.7 million by 2027. More details on the industry outlook are shared in the charts on the following pages, along with a glimpse at a few



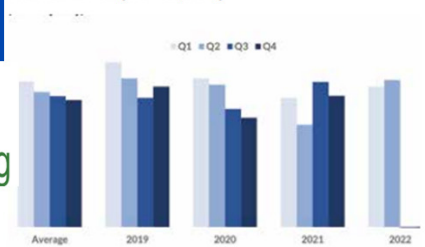
Industry Outlook:
Sales Expected to Keep Growing

\$28.3
Annual average facility revenue in millions forecast in 2023.

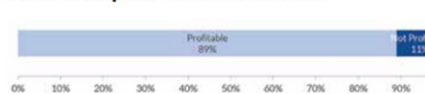
尽管大多数铸造企业预计 2023 年将出现经济衰退，但稳定增长的订单使铸造厂商倍感乐观。

2022 年，美国铸件销售迎来了第二个强劲增长的年份。2020 年美国铸造业销售额有所下降，整体行业收入从 442 亿美元降至 367 亿美元。2021 年美国铸造业的铸件销售额回升达到 433 亿美元，2022 年继续上升达到 463 亿美元。

Plant Utilization (% of Capacity)



Percent of Companies That Are Profitable-2021



这比 2022 年增长了 4.3%。2022 年，铸造企业的运营费用占收入的 82.8%，总运营费用同比增长了 12.1%。

铸造企业运营费用的构成可以细分如下：材料成本占 51.5%，员工费用占 32.8%，建筑建设费用占 7.3%，其他费用占 8.9%。根据该报告，估计 89% 的铸造企业可以盈利，平均净收入占总收入的 9.2%。美国的工厂数量（不包括艺术和教育类铸造机构）估计约为 1715 家。2021 至 2022 年间，每处工厂的收入增长了 10.1%，预计 2023 年将增长 4.6%。预计到 2027 年，每个工厂的年收入将达到 3370 万美元。关于行业前景的更多细节，请参见以下图表，

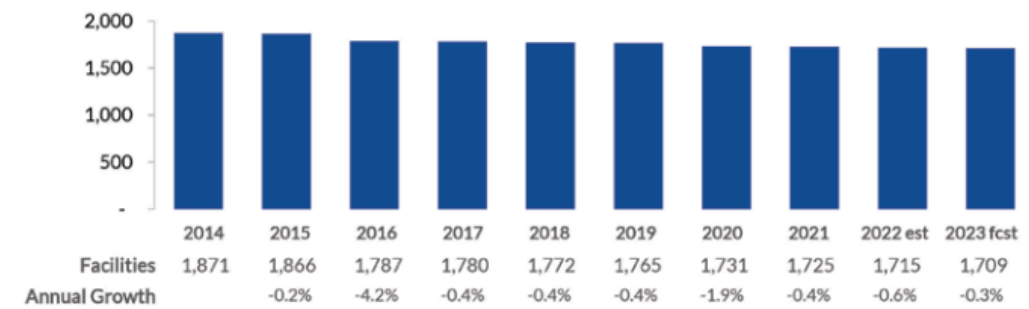
global casting production trends in Table 1.

The AFS Metalcasting Forecast & Trends is developed from core data sourced from comprehensive business surveys from the Census Bureau, Bureau of Labor Statistics, and other government agencies. ■

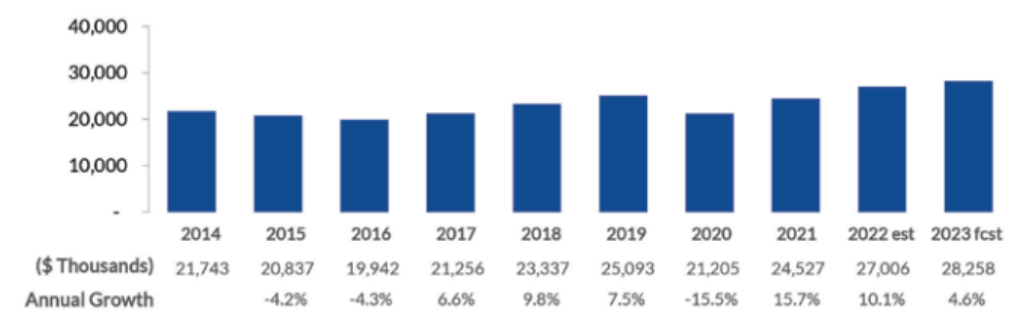
在表 1 中展示了全球铸件生产趋势的部分数据。

美国铸造协会的铸件产量预测与趋势指数是根据人口普查局、劳工统计局和其他政府机构的综合商业调查中的核心数据而分析获得的。■

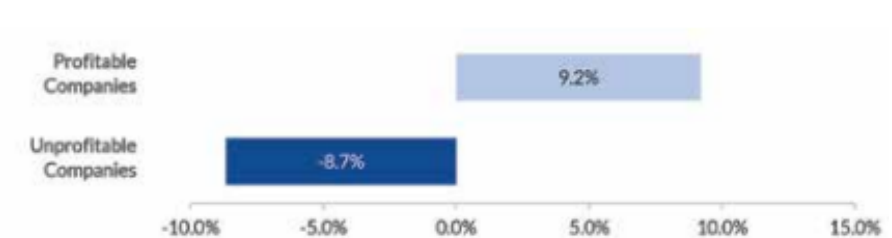
Number of Facilities (Excluding Art Foundries and Educational Foundries)



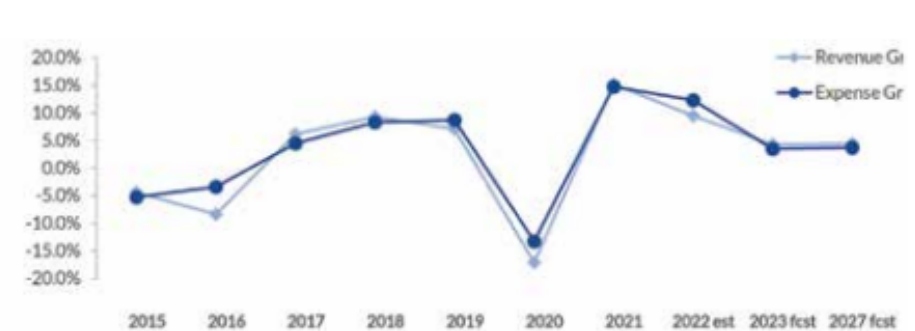
Revenue Per Facility (\$ Thousands)



Average Net Income as a Percent of Revenues-2021



Revenue Growth per Facility Versus Operating Expense Growth per Facility



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Elkem Supports Its Customers With Solving Shrinkage Issues

埃肯公司助力客户解决缩松缺陷

The growth and diversity of iron casting in the Asian markets has led foundries to re-examine their inoculation processes. New iron grades demand new process solutions and end users require higher specifications.

Elkem recognizes these challenges and has a dedicated team of metallurgists and process engineers capable of supporting foundries. Backed up by extensive laboratory facilities and a R&D group, we work together with our customers to solve issues, improve processes and eliminate waste.

Traditionally, the Asian market has used calcium/barium based inoculants and these are widely available, although of hugely variable quality. However, their low potency leaves them unsuited to many applications in this challenging market, such as shrinkage control in both grey and ductile irons, producing higher strengths in thinner section light weight castings and matrix structure. All of which offer the opportunity for an examination of the inoculants available today.

In light of this, Elkem's technical experts recently consulted a foundry that manufactures ductile iron castings for critical machinery parts, weighing up to 10 tonnes. They experienced challenges with shrinkage, which resulted in rejects at a cost of \$365,000 per year as they were only detected after machining. The foundry's end user questioned the continuity in supply and quality, and thus business was at stake.

Design solutions undertaken by the foundry resulted in minor improvements, which were insufficient for the end user's situation. Trials with chills improved the shrinkage defects but unfortunately, they were not able to remove the defects to an acceptable level.

Together with the foundry staff, Elkem technicians went on-site and analysed the situation. The foundry used a 7% Mg, 1.5% TRE alloy in the treatment system, covered by steel coils. A calcium / barium inoculant was used in both the first stage and subsequent in-stream process.

Samples were sent to one of Elkem's regional research labs where expert metallurgists performed extensive analysis. As a result, they recommended changing the alloying materials.

Elkem technicians then performed a trial with LAMET™ 5922, a nodularizer containing 5.9% Mg and 0.5% La. Elkem's LAMET™ has been proven in helping to eliminate shrinkage. The cover material was changed to FeSi. ULTRASEED™ Ce inoculant was then used in-stream, because of its strong potency in reducing the irons tendency to shrink.

After the trial it was clear that the casting results

亚洲市场铸铁件需求的增长和多样性要求，导致铸造厂重新检查孕育工艺。新的铸铁等级需要新的工艺解决方案，而最终用户对技术规范的需要更高。

埃肯公司意识到这些挑战，并组建专业的冶金学和工艺工程师团队，能够支持铸造厂。在广泛的实验室设施和一个团队的支持下，我们与客户一起解决问题，改进工艺并消除废品。

传统上，亚洲市场使用以钙 / 钡基孕育剂，尽管对质量控制的变化很大，这种孕育剂仍被广泛使用。然而，因其低效，这种孕育剂在具有挑战性的市场的许多应用上并不适合，如灰铁和球墨铸铁的收缩控制，产生更高强度的薄壁轻量化铸件和复杂结构铸件。所有这些都提供了检验目前可用的孕育剂的机会。

有鉴于此，埃肯公司的技术专家最近接到一家为关键机械部件生产球墨铸铁件的铸造厂的咨询，铸件重达 10 吨。他们经历了缩松缺陷的挑战，因为缺陷只有在加工后才发现，导致了每年 36.5 万美元的成本增加。铸造厂的最终用户质疑供应和质量的连续性，因此业务岌岌可危。

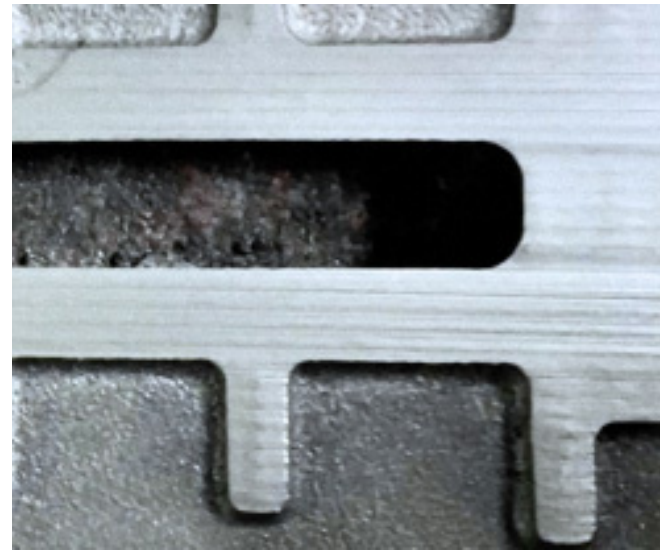
由铸造厂承担的设计解决方案起到了微小的改进，但不足以满足最终用户的要求。冷铁试验改善了收缩缺陷，但不幸的是，不能将缺陷消除到可接受的水平。

埃肯公司的技术人员与铸造厂的工作人员一起在现场分析了情况。铸造厂在处理工艺使用 7% 的镁，1.5% 的稀土合金，上面覆盖着钢硬币。钙 / 钡孕育剂在第一阶段和随后的随流孕育中都被使用。

样品被送到埃肯公司的区域研究实验室，冶金专家在那里进行了大量的分析。因此，他们建议更换孕育的合金材料。

埃肯公司的技术人员随后用 LAMET™ 5922 进行了一项试验，这是一种含有 5.9% 镁和 0.5% 镧球化剂。埃肯公司的 LAMET™ 已被证明有助于消除缩松缺陷。覆盖材料改为硅铁。然后使用 ULTRASEED™ 铈孕育剂随流孕育，因为其具有较强的效力，可以降低铸铁收缩的趋势。

试验后，很明显，随着缩松孔隙的消除，铸件质量显著改善。



Casting results before and after the modified alloy additions
改变孕育合金前后的铸件

improved significantly with shrinkage porosity eliminated.

Introducing LAMET™ 5922, ULTRASEED™ Ce, and FeSi to the process resulted in major improvements:

The scrap rate dropped from 30 % to 2 %. There was also a very low shrinkage level, accepted by the end user, and there was no need for the use of chills or any other production process change.

Not only was the foundry able to save annual costs immensely by reducing the scrap rate, but the foundry's customers' satisfaction also improved resulting in a continuation of the business.

For more information on new inoculation technologies, please contact your local Elkem representative or visit our website www.elkem.com/foundry.

Join us at Metal China 2023, 8-11 May, Hall S14, Stand B03. We are looking forward to welcoming you and talking about the best solutions for your foundry! ■

引入 LAMET™ 5922 球化剂、ULTRASEED™ 钕孕育剂，覆盖硅铁的工艺方案取得重大改进：废品率从 30 % 下降到了 2%。缩松缺陷下降到极低的程度，获得最终用户的认可，并且不需要使用冷铁或任何其他生产工艺的改变。

铸造厂不仅能够通过降低废品率来极大地节省年度成本，而且客户的满意度也有所提高，从而使业务得以继续。

有关更多新的孕育技术的信息，请联系当地埃肯公司的代表或访问我们的网站 www.elkem.com/foundry。

2023 年 5 月 8-11 日，诚邀您来到中国国际铸造博览会 S14 号馆 B03 展位。我们期待您的莅临，并为您的铸造工艺讨论最佳的解决方案! ■

Plasma Cutting for Structural Castings Instead of Stamping

等离子切割代替冲压生产结构铸件

SIR's solution adapts to changes in production processes in the automotive industry and the growing need for alternative machining operations

The need for innovation

With the rise of electric cars in the automotive sector, manufacturers have been investing for years in design and production processes that help further reduce the mass of their vehicles, which is often compromised by the weight of the batteries that power them.

An obvious candidate for significant weight reduction is the chassis, the skeleton that forms the main structure of the vehicle. In the automotive industry, the chassis traditionally consists of a series of castings that are then assembled in various processes to form a complete chassis. This requires a long chain of different components, a long list of suppliers and a complex assembly line with high production and maintenance costs.

One-piece half frames and the need for alternative processes

The latest and most recent innovation in this field goes in a completely different direction from these traditional processes. The introduction of aluminum die-casting of frames, not only for small components that then have to be assembled, but directly as whole half-frames with larger dimensions, is a goal that was previously considered difficult to achieve. This eliminates much of the assembly production process described above, which significantly lowers costs and reduces the need for special machinery.

Plasma cutting instead of stamping

Another important detail that emerges because of this innovative process concerns the removal of sprues during the machining phase of the frame. In the conventional method, the sprues are separated from the main body of the part by punching. This was possible and cost-effective due to the small size of the frame parts, which do not require over-complicated or oversized punching machines. Die-casting whole frames, on the other hand, logically results in a casting whose channels extend over a larger area, making the stamping process more expensive and less flexible.

Flexibility and cutting quality: one partnership and one solution

SIR (Soluzioni Industriali Robotizzate), long a leader in building robotic cells for various sectors and with a strong presence in the automotive industry, and HYPERTERM, a global manufacturer of plasma generators, have entered into a

SIR 的解决方案适应汽车工业生产流程的变化以及对替代机加工操作日益增长的需求。

创新需求

随着电动汽车在汽车行业的兴起，多年来，制造商一直在投入设计和生产流程的研发，以帮助进一步减轻汽车的重量，而汽车的重量往往会受到为其提供动力的电池重量的影响。

能够极大减轻重量的重点方向是底盘，即构成车辆主要结构的骨架。在汽车行业，底盘由一系列铸件组成，然后通过各种工艺进行组装，形成一个完整的底盘。这需要很长的由不同部件组成的产业链来完成、涉及到很多供应商和一条复杂的生产和维护成本高的装配线。

一体化结构件对替代工艺的需求

在这方面，最先进和最新创新方向朝着与传统工艺完全不同的方向发展。引入铝压铸结构件，不仅代替了必须组装的小部件，而且直接作为更大尺寸的半框架结构，这在以前被认为是难以实现的目标。一体化压铸无需上述大部分的组装生产过程，因此显著降低了成本并减少了对特殊机械设备的需求。

等离子切割代替冲压

由于创新工艺的出现，涉及到的另一个重要环节是框架结构件机加工前去除浇口。在传统工艺中，浇口通过冲压与零件主体分离。因为框架部件的尺寸很小，不需要过于复杂或超大的冲压机，这在以前是可行且具有成本效益的；但是，从逻辑上看，整个框架的压铸会导致铸件的通道延伸到更大的区域，从而导致冲压的费用更昂贵、更不灵活。

灵活性和切割质量：合作伙伴和解决方案

SIR (Soluzioni Industriali Robotizzate) 公司一直是为各行业提供机器人电池的领导者，在汽车行业有着强大的影响力。SIR 公司与全球等离子体发生器制造商 HYPERTERM 公司已达成合作，通过机器人焊炬优化等离子体切割应用。等离子切割已被证明是在单件铸件中去除浇口的最具成本效益和效率的冲压替代方案，

collaboration to optimize plasma cutting applications with robotic torches. Plasma cutting has proven to be the most cost-effective and efficient alternative to punching for removing sprues in one-piece castings, offering convenience, cost savings, flexibility, and ease of use. Features that are due to the innate characteristics of the robots, which offer the ability to adapt to different types of cuts on different components, thus offering cost savings; and to the characteristics of the plasma torch, which guarantees lower consumption and costs than the alternatives, while allowing clean cuts, i.e. requiring fewer finishing steps in the following stages.

In the event of a batch change, there is no longer any need to replace costly and cumbersome punching tools; all that is required is a simple reprogramming of the robot paths in conjunction with a possible adjustment of the reference support and the support of the workpiece. The two companies are therefore working together to optimize these applications to support the cutting of sprues of different thicknesses, adjust cutting speeds and achieve an ever higher level of quality. One example is the application recently developed by SIR for a major automotive customer. The application takes the form of a robotic cell and aims to dematerialize aluminum castings, in particular front and rear half-frames, using a plasma torch. The cell consists of handling robots that operate cutting cells where other robots in booths cut and remove sprues and runners.

The system is complemented by manual deburring cells, which will also be robotized in the future. The main focus of the application, as already mentioned, is the use of technologies that enable clean cuts with much greater flexibility than conventional cutting solutions. The result is a cell whose robots guarantee a high degree of adaptability to the machining of parts of different sizes and shapes, characterized by high machining quality and very high efficiency, offering a solution for customers who are evaluating this new frame casting process with growing interest. ■

提供了便利、灵活性和易用性，节约了成本。机器人的固有特性提供了适应不同部件的切割能力，从而节省了成本；由于等离子体炬的特性，能够进一步降低消耗和成本，同时可以进行精简切割，即在之后的操作步骤需要较少的精加工处理。

在批量更换的情况下，不再需要更换昂贵而笨重的冲压工具；所需要的只是结合参考支撑件和工件支撑件的可能调整来对机器人路径进行简单的重新编程。因此，这两家公司正在通过合作优化这些应用程序，以支持不同厚度的浇口切割、调整切割速度、获得更高的质量。一个例子是，SIR 公司最近为一个主要的汽车客户开发了应用程序。该应用程序采用机器人单元的形式，旨在使用等离子体炬对铝铸件，特别是前半框架和后半框架进行材料减量处理。机器人单元由操作切割的工业机器人组成，其他机器人在工位上切割和移除浇口和浇道。

该系统还包括手动去毛刺单元，该单元也将在未来实现机器人化。如前所述，该应用的重点是使用比传统切割解决方案具有更大灵活性的精益切割技术。该单元的机器人能够保证加工不同尺寸和形状的零件具有高度的适应性，其特点是具有更高的加工质量和生产效率，增强了正在对这种新的结构件铸造工艺进行评估的客户兴趣。■



Advancing Foundry Digitalisation: Norican's Monitizer and ABP's Digital Services Agree to Interface their Products

推进铸造厂的数字化进程：诺瑞肯集团的 Monitizer 和 ABP 的数字化服务同意进行产品对接

Monitizer, part of Norican Group (DISA, Simpson Technologies, Wheelabrator, StrikoWestofen and ItalPesseGauss), and ABP Induction Systems have agreed to build links between their digital systems.

The two foundry suppliers will now collaborate to create an interface that will share furnace data from ABP Digital Services with the Monitizer® Suite from Norican.

Monitizer is a modular, equipment- and brand agnostic IIoT platform for the foundry industry. Monitizer | DISCOVER collects, aggregates and displays data from multiple equipment, lines or global sites, with user-friendly reporting and visualisation tools that help unlock serious process improvements - fast. Monitizer | PRESCRIBE harnesses the power of AI to optimise an entire foundry process and is proven to drive average scrap reductions of 40%.

"I am delighted to announce that we will work with ABP to support data transfers between our systems," says Nina Dybdal Rasmussen, who heads up the Monitizer brand at Norican. "The more data our customers can extract, the greater the potential for improvement - which is why we built Monitizer as an IIoT system capable of connecting all parts of the line. ABP enables a vital part of the foundry process and integrating data from their equipment will be a huge benefit for our joint customers."

Till Schreiter, President and CEO of ABP Induction Systems: "Foundries need to be able to bring their data together in one place and everyone will benefit from this practical, constructive agreement."

Nina Dybdal Rasmussen, Head of Monitizer: "ABP enables a vital part of the foundry process and integrating data from their equipment into Monitizer will be a huge benefit for our joint customers."

ABP's portal "myABP.com" is the gateway into digitalisation. It provides foundry equipment documentation plus specialised hardware and software which support intelligent management of equipment and skills while enhancing communication between foundry personnel. It also offers virtual emotional learning environments and digital twins, as well as a fully

Monitizer 和 ABP 感应系统已同意在其数字化系统之间构建连接。这两家铸造供应商现在将合作打造一个接口，用于与 Monitizer@Suite 共享来自 ABP 数字化服务的工业炉数据。

这两家铸造行业供应商，将强强联合，打造出可以同时共享感应炉数据给 ABP 数字服务和诺瑞肯 Monitizer 数字化解决方案的交互系统。

Monitizer 是一个与设备和品牌无关的模块化 IIoT 平台，适用于铸造业。Monitizer|DISCOVER 收集、汇总和显示来自多个设备、生产线或全球站点的数据，并提供用户友好的报告和可视化工具，这些工具可以帮助铸造厂快速实现重大工艺改进。Monitizer|PRESCRIBE 利用人工智能的力量来优化整个铸造工艺，实践证明，平均废品率降低了 40%。

"我很高兴地宣布，我们将与 ABP 合作，支持在我们的系统之间实现数据传输，" Monitizer 品牌负责人 Nina Dybdal Rasmussen 说。

"我们的客户提取的数据越多，实现改进的潜力就越大——因此，我们把 Monitizer 构建成了一个能够连接生产线所有部分的 IIoT 系统。ABP 实现了铸造工艺的关键部分，整合来自其设备的数据将为我们的共同客户带来巨大的好处。"

"铸造厂需要能够将他们的数据汇集到一个地方，每个人都将从这个实用的建设性协议中受益。" ABP Induction Systems 总裁兼首席执行官 Till Schreiter 说。

"ABP 实现了铸造工艺的关键环节，整合来自其设备的数据将为我们的共同客户带来巨大的好处。" Monitizer 负责人 Nina Dybdal Rasmussen 说。

ABP 的门户网站 "myABP.com" 是通向数字化的途径。该网站提供所有相关的铸造设备文件、专用硬件和



automated service application that includes a ticketing application and a 24/7 spare parts web store.

“Foundries need to be able to bring their data together in one place and everyone will benefit from this practical, constructive agreement,” says Till Schreiter, President and CEO of ABP Induction Systems. “ABP and Norican are both highly motivated to help digitalise the foundry industry and linkages like this between different suppliers are vital to support completely connected digital eco-systems. Without them, it will be impossible for foundries to extract the full value from their data.”

For more information:

<https://monitizerdigital.com>

<https://abpinduction.com/en/digitalsolutions/myabp-portal/> ■

软件，以提高铸造厂设备的智能化水平、改善铸造厂人员的技能管理和沟通、增强虚拟情感学习环境和数字双胞胎以及提供全自动的服务应用，包括全天候开放的备件网店和票务应用。

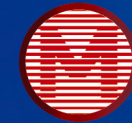
“铸造厂需要能够将他们的数据汇集到一个地方，每个人都将从这个实用的建设性协议中受益。” ABP Induction Systems 总裁兼首席执行官 Till Schreiter 说。

“ABP 和诺瑞肯都非常积极地帮助铸造行业实现数字化，而不同供应商之间的这种链接对于支持完全互联的数字化生态系统至关重要。没有这种链接，铸造厂就不可能从他们的数据中提取全部价值。”

了解公司更多详情，请访问：

<https://monitizerdigital.com>

<https://abpinduction.com/en/digitalsolutions/myabp-portal/> ■



第二十二届中国国际铸造博览会

The 22nd China International Foundry Expo (Metal China)



第十七届中国国际压铸工业展览会

The 17th China International Die Casting Industry Exhibition

第十七届国际有色及特种铸造展览会

The 17th International Nonferrous and Special Casting Exhibition

2024.7.4-7.7 | 国家会展中心（上海）

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中国铸造协会展会微信平台



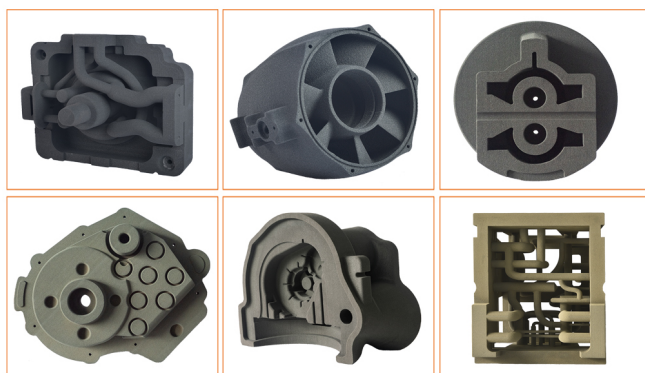
中国铸造协会微信平台

广东峰华卓立科技股份有限公司是一家集工业级3DP（粘结剂喷射技术）打印装备研发、制造、销售及应用服务为一体的综合性供应商，近20年来，一直深耕3DP打印技术的创新与研发。

2021年公司成功推出第五代砂型打印机，产品远销日本、巴西、印度、俄罗斯等国，有力推动了国内外整个砂型砂型3D打印技术在铸造行业的应用和发展，已成为国际知名的工业级3D打印解决方案供应商和铸造企业合作伙伴。

2022年推出第二代金属、陶瓷打印机，并通过建设3D打印+铸造智能产线、金属、陶瓷粉末3D打印+烧结成型智能示范基地以及快速智造云平台，探索分布式3D打印定制化生产模式，不断推进中国制造业向数字化、绿色化、智能化升级。

打印应用案例



砂型3D打印机>>>

优点

- 大型铸件产品优选机型；
- 适合柔性产线布局，满足大规模快速生产；
- 核心部件采用国际知名品牌；
- 打印过程无需值守，打印速度平均24秒/层；
- 智能、远程功能一应俱全；
- 低使用成本，新旧料混合利用，余砂在线循环使用。

技术参数

成型有效尺寸 (mm)	2200*1000*800/1000
打印分辨率 (dpi)	300*400 or 400*400
打印速度 (s/layer)	24
打印效率 (L/H)	160
打印层厚 (mm)	0.2-0.5
打印精度 (mm)	±0.3
砂型材料	硅砂、陶瓷砂、合成砂、CB砂等
粘结剂材料	FH-01 (呋喃) / FH-02 (无机) / FH-03 (有机)



PCM2200

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