中德智能制造联盟
Alliance for Sino-German Intelligent Manufacturing

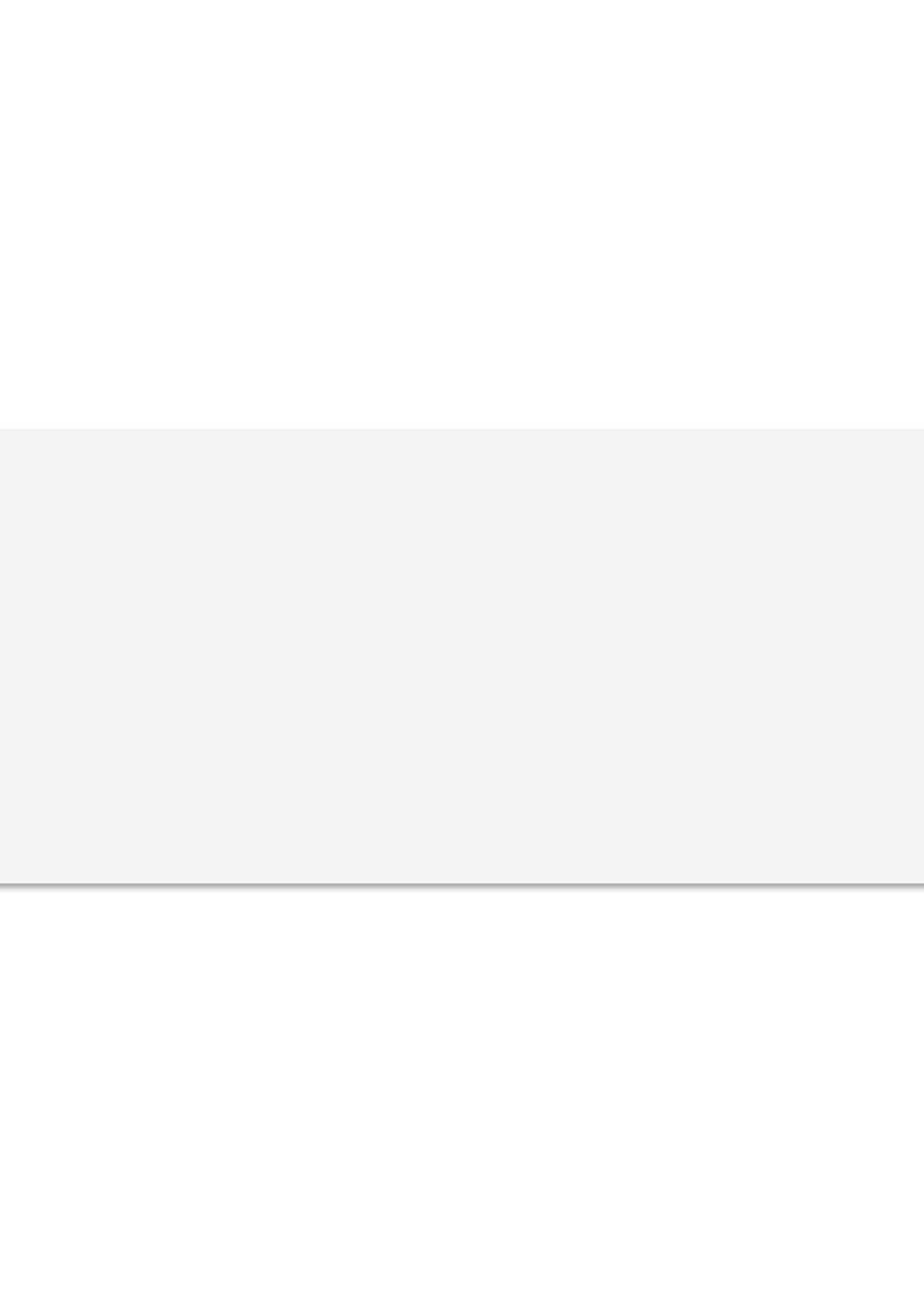# WHITE PAPER ON DIGITAL TRANSFORMATION OF SINO-GERMAN MANUFACTURING

中德制造业数字化转型白皮书

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前　言

　　《中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要》，明确提出要"打造数字经济新优势"，并提出"充分发挥海量数据和丰富应用场景优势，促进数字技术与实体经济深度融合，赋能传统产业转型升级"。为此，还着重规定了包括智能制造在内的十大数字化应用场景的具体范围，作为快建设数字经济、数字社会、数字政府，以数字化转型整体驱动生产方式、生活方式和治理方式变革的重要指引。

　　制造业数字化转型就是要充分发挥数字技术在传统制造产业发展中的赋能引领作用，通过推动实现生产流程的数字化，可将制造优势与网络化、智能化相叠加，有利于提高生产制造的灵活度与精细性，实现柔性化、绿色化、智能化生产，是转变我国制造业发展方式、推动制造业高质量发展的重要途径。

　　在深度推动制造业数字化转型的进程中，德国"工业 4.0"和中国"制造强国"战略具有典型代表意义。德国"工业 4.0"源自于其企业界、产业界是从定制化、个性化的终端需求出发解决生产过程中的质量问题、效益问题和效率问题而自发形成的自下而上的战略。虽然其整体框架与中国的国情有很多不同，但其实践探索仍然有很多经验可供借鉴。

　　因此，长期以来，中德两国基于制造业转型升级，在政府、产业及企业等各层面都保持着紧密联系。其中，2014 年 10 月签署的《中德合作行动纲要》，开启了两国建立互利共赢的创新伙伴关系、推动系统性和战略性合作的新时期。"德国技术"与"中国制造"优势互补，奠定了两国产业合作的良好基础。

　　如今，中德产业合作的外部形势正在发生深刻变化。一方面，随着经济全球化的迅猛发展，国际产业转移呈现出与以往不同的新特征。另一方面，经过改革开放 40 多年的发展，中国制造业取得了令人瞩目的进步，甚至在数字化和信息技术、高速机车制造等诸多领域具有了全球竞争能力。

作为推进中国"制造强国"战略与德国"工业 4.0"对接的重要平台，中德智能制造联盟支撑建立中德智能制造企业、行业间对话机制，搭建产业与技术合作交流平台，促进中德两国在智能制造领域的务实合作与共赢发展。进入新的发展时期，中德智能制造合作将呈现新的内涵、特征和要求。

为了更高效地推动两国在智能制造领域的务实合作、更准确地把握产业技术趋势，以及更精准地对接客户需求，中德智能制造联盟通过广泛调研，编制发布《中德制造业数字化转型白皮书》，从中德智能制造合作背景、政策发布、产业趋势、发展概况、实践案例等多方面进行综合分析，展示中德两国智能制造领域的合作成果，并为推动中德智能制造领域务实合作、中德智能制造试点示范项目顺利开展，以及借鉴德国"工业 4.0"平台经验加速构建我国制造业高质量发展推进体系等提出建设性的意见建议。

Preface

In Outline of the 14th Five−Year Plan for National Economic and Social Development of the People's Republic of China and the Long−Range Objectives through the Year 2035, Chinese government has made it clear that it should create new advantages in the digital economy. This outline also proposed to give full play to the advantages of massive amounts of data and rich application scenarios, promote extensive integration of data elements with the real economy and drive the transformation and upgrading of traditional industries. It also underlined the scope of ten application scenarios of digital technologies, including intelligent manufacturing, as an important guide to change people's lifestyle and the modes of production and government governance through digital transformation like accelerating the construction of the digital society, digital economy and digital government.

Digital transformation of manufacturing industry is to give full play to the leading and empowering role of digital technology in the development of traditional manufacturing industry. By promoting the digitalization of the production process, China can improve on its manufacturing through networking and intelligent development, which is conducive to improving the flexibility and sophistication of production and manufacturing, and achieving flexible, green and intelligent production. As a result, it can transform the development mode of China's manufacturing industry and promote its high−quality development.

German "Industrie 4.0" and China's "Manufacturing Power" strategies are typical examples of deeply promoting the digital transformation of manufacturing industry. The German "Industrie 4.0" is a bottom−up strategy formed in the process where enterprises and industrial communities seek to solve the problems of quality, profitability and effectiveness in the production based on

the customized and personalized end-market demand. Although its overall framework cannot be applied in China, there are still many lessons to be learned from its practices.

Therefore, for a long time, China and Germany have maintained close ties at all levels, including government, industry and enterprises, with the aim to transform and upgrade both manufacturing industries. The Joint Program of Action on Cooperation: Shaping Innovation Together published in November 2014 has opened a new era featuring mutually beneficial partnership for innovation and systematic and strategic cooperation. The complementary advantages of "German technology" and "Made in China" have laid a good foundation for industrial cooperation between the two countries.

Nowadays, the external situation of Sino-German industrial cooperation is undergoing profound changes. On the one hand, with the rapid development of economic globalization, international industrial transfer presents new features. On the other hand, after more than 40 years of reform and opening up, China's manufacturing industry has made remarkable progress and even has global competitiveness in many fields such as digitalization, information technology and high-speed train manufacturing.

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In order to promote the pragmatic cooperation between the two countries in the field of smart manufacturing more efficiently, grasp the industrial technology trends more accurately, and meet with customer needs more precisely, Alliance for Sino-German Intelligent Manufacturing has compiled and released Sino-German

White Paper on Digital Transformation of the Manufacturing Industry through extensive research. This paper contains a comprehensive analysis of Sino—German intelligent manufacturing cooperation from perspectives including background, policies, industrial trends, development overview, cases and others. It demonstrates the achievements of Sino—German cooperation in the field of smart manufactur—ing. It also provides constructive suggestions to promote practical cooperation in the field of Sino—German smart manufacturing, to build pilot demonstration pro—jects, and to accelerate the construction of China's high—quality manufacturing development system using the experience of the German Plattform Industrie 4.0.

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一、背　景

自 2014 年 10 月签署《中德合作行动纲要》以来，中德两国的合作框架基本确立，工作机制逐渐完善，双边交流不断深入，项目合作稳步推进，呈现向好的发展态势。目前，中德合作不断取得新进展，确立了政府搭台、企业主体、产学研共同参与的合作机制，形成了以智能制造为切入点、多领域合作齐头并进的良好态势，为进一步推动务实合作奠定了坚实基础。

2015 年 7 月，《中华人民共和国工业和信息化部与德意志联邦共和国经济和能源部推动中德企业开展智能制造及生产过程网络化合作的谅解备忘录》（以下简称《合作备忘录》）在北京签署，旨在落实两国领导人共识，在工业 4.0 以及制造业数字化、网络化、智能化转型方面加强政策对接、产业合作与联合创新。

2015 年 10 月，中德召开了第一次工作组会议，会议在搭建交流机制、智能制造标准化、中小企业合作、开展智能制造试点示范、人才培养、前瞻性研究等方面形成了诸多共识，标志着两国推动智能制造合作的经常性工作机制初步建立。目前，按照《合作备忘录》要求，两国已经建立了三个层次的联合工作机制：第一层次是副部长级对话机制，确定了每年在中德两国交替召开副部长级会议；第二层次是司局级对话机制；第三层次是执行平台对接机制，两国政府各自指定执行平台，负责企业间技术性问题的沟通。2019 年 4 月 9 日，中德智能制造联盟在深圳成立，成为推进"制造强国"战略与德国"工业 4.0"对接的重要平台。

在这一合作机制的推动下，汇聚了两国企业、行业组织、专家学者等各界代表，搭建了产业合作工作组、标准化工作组、科研工作组等交流平台，合作成果丰硕。在产业合作方面，遴选出中德合作试点示范项目共 5 批 54 项。在技术交流领域，两国进一步加强了高端装备、增材制造、新能源、新能源汽车及关键零部件等领域的技术交流与合作。在产业合作领域，两国在汽车、光伏、工程机械、电力装备、轨道交通、节能环保等领域建立了良好的合作基础。合作机制成立 6 年来，在推动中德智能制造及生产过程网络化合作方面发挥了重要作用，得到两国各界高度评价和踊跃参与。

中德合作不断取得新进展，确立了政府搭台、企业主体、产学研共同参与的合作机制，形成了以智能制造为切入点、多领域合作齐头并进的良好态势，为进一步推动务实合作奠定了坚实基础。

二、德国"工业 4.0"及中国智能制造发展现状及未来趋势

1.德国"工业 4.0"的发展现状及趋势

德国以强大的工业闻名于世。为了保持制造业的领先优势，提高生产效率，德国政府提出了德国"工业 4.0"的概念，也就是第四次工业革命，目的是建立一个与互联网融合的智能化先进制造方式，提高效率、降低成本和加快反应速度，从而保护"德国制造"的国际领先地位。

1.1 发展现状及呈现出的问题

德国工业 4.0 平台是德国工业 4.0 战略的实施主体。整个平台的参与者可以分成三类：政府、企业以及教育科研机构。政府负责搭建政策框架与促进合作；教育科研机构负责为"工业 4.0"研究推进举措和方向，并提供理论基础；企业则是"工业 4.0"的具体实践者。

德国虽然对实现"工业 4.0"战略目标持乐观态度，但也清醒地认识到在数字化转型过程中依然面临着诸多挑战。主要包括三个方面：IT 建设和应用在企业层面比较强，但在整个社会比较弱；中小企业还是缺少面向数字化时代的解决方案；商业模式创新方面与领先国家差距较大。

1.2 取得的成效及优势

如今，"工业 4.0"平台已取得不少成效：

知识和信息传播节点。在线图书馆汇集了政府相关战略文件以及平台各工作组的研究成果等内容。

用户案例集中展示了德国各类型企业应用"工业 4.0"解决方案的实例。

为企业开展测试提供多方面支持。平台详尽列出全德国 500 多处能够开展相关测试的地点，以便于企业获取相关资源。在德国联邦教育和研究部的支持下，平台可以为中小企业选择适合自己项目的测试点提供建议，还能够为这些企业提供资金支持。

广泛开展国际合作。平台已与美国、中国、法国、日本等主要国家建立了联系或提出了合作计划，力图让"工业 4.0"变成"世界性课题"，也为本土企业走向国际市场提供了便利。

所获得领先优势有以下几点：

为了保持制造业的领先优势，提高生产效率，德国政府提出了德国"工业 4.0"的概念，也就是第四次工业革命，目的是建立一个与互联网融合的智能化先进制造方式。

"工业 4.0"的实际参与者是企业，特别是德国的制造业，目前已经形成了规模效应，是行业发展的核心力量。

德国目前基于"工业 4.0"已经有多家领先企业，在很多高端领域和环节已经形成了群体性优势，特别是国际化大企业。例如西门子的"数字化企业平台"系统为数字制造提供了载体；宝马集团的虚拟手势识别系统使得汽车制造再进一步；大众用机器人制造汽车，实现了极高的人力替代效率；ABB 强大、精细而全面的机器人产品在世界上有着明显的竞争优势；博世力推用于工厂智能化的射频码系统；SAP 推动云平台互联万物，实现大数据支撑决策。

在工业 4.0 技术和产业变革中，不仅仅是大企业特别是跨国企业做主导，德国政府也尤其重视为广大中小企业提供公共服务。以家族企业为主的中小型企业，也被称为与"工匠精神的延续者"，这些德企不追求规模生产，以"精而专"著称。虽然相当一部分德国中小企业对数字化转型还抱有怀疑或观望态度，但是德国工业 4.0 保障中小企业的参与，如德国工业企业联合会是平台的重要参与方，同时也代表着 10 多万家企业会员的利益，德国工业 4.0 平台为中小企业提供信息、测试、资金等多方面支持，以应用实例化解中小企业的顾虑。

2.中国智能制造的发展现状及趋势

智能制造是基于新一代信息技术与先进制造技术深度融合，贯穿于设计、生产、管理、服务等制造活动的各个环节，具有自感知、自学习、自决策、自执行、自适应等功能的新型制造形式。加快发展智能制造，是培育我国经济增长新动能的必由之路，是抢占未来经济和科技发展制高点的战略选择，对于推动我国制造业供给侧结构性改革，打造我国制造业竞争新优势，实现制造强国具有重要战略意义。

2.1 中国制造业步入平稳发展阶段

近年来，中国经济发展已经由高速增长转入高质量发展阶段，工业快速发展时期已过，进入新常态。尽管制造业增加值在全国 GDP 总量中的比重呈下滑趋势，但以制造业为代表的实体经济才是中国经济高质量发展的

核心支撑力量。

2.2 中国智能制造水平相对薄弱 制造业亟待升级

目前，我国制造行业仍处于工业 2.0（电气化）的后期阶段，存在质量基础相对薄弱、产业结构不合理、资源利用率偏低、行业信息化水平不高、劳动力成本提高等问题。

一是智能制造基础理论和技术体系建设滞后。目前，我国主要侧重智能制造技术追踪和技术引进，而基础研究能力相对不足，对引进技术的消化吸收力度不够，原始创新匮乏；控制系统、系统软件等关键技术环节薄弱，技术体系不够完整。

二是我国发展智能制造的数字化基础较为薄弱，制造业发展整体上还处于机械自动化向数字自动化过渡阶段，如果以德国工业 4.0 作为参照系，比较一致的看法是我国总体上还处于 2.0 时代，部分企业在向 3.0 时代迈进。

三是关键技术和核心部件受制于人。高端传感器、智能仪器仪表、高档数控系统、工业应用软件等市场份额不到 5%，大型工程机械所需 30Mpa 以上液压件全部进口，大型转载机进口部件占整机价值量的 50%-60%。

四是高端软件产品缺乏。我国制造业的"两化"融合程度相对较低，低端 CAD 软件和企业管理软件得到很好普及，但应用于各类复杂产品设计和企业管理的智能化高端软件产品缺失。

五是企业系统集成能力较为薄弱，缺乏国际级大型企业。

2.3 中国智能制造行业发展驱动因素

2.3.1 人力成本上升 倒逼制造业转型升级

制造业是人力密集的行业。但是，当前中国老年人口比例已经严重超标，已经成为世界上老年人口最多的国家。自 2000 年开始我国便已步入老龄化社会，并且正在朝着深度老龄化社会快速迈进。根据国家统计局统计数据，2018 年中国 60 周岁及以上人口数量为 2.5 亿人，占中国总人口的比重达到17.9%，预计到2050 年老年人口规模将达到 5 亿。

由于人口老龄化加快，我国劳动力人口供给不断减少，而劳动人口锐减则导致人力成本上升。21 世纪以来，中国制造业平均工资逐年增长，增速加快，中国劳动力成本优势逐渐丧失。在第四次制造业转移中，劳动密

集型的低端产业倾向于向人力成本更低、环保要求更宽松的东南亚国家转移；而部分中高端产业出于对自动化智能化生产的需求出现回归欧美的迹象，我国制造业面临着两方面的压力。因此，劳动力减少、人力成本上升倒逼制造业向智能化自动化升级，智能制造能够替代人力劳动甚至外延人的能力，提高生产效率，是制造业未来的发展趋势。

2.3.2 新一代信息技术持续创新迭代 驱动制造迈向智造

如今，在传统制造业增长放缓的情况下，高技术制造业持续保持较快增长，特别是数字经济发展，制造业数字化、网络化、智能化发展带来的数字红利使得制造业发展拥有广阔前景。

随着以大数据、云计算、人工智能、物联网、5G、区块链等新一代信息技术在企业研发设计、生产制造、经营管理、运维服务等全环节应用的逐步深化，制造业不断从流程驱动向数据驱动转变，两化融合也不断从单项应用向综合集成、协同创新发展，加速推进以软件定义、数据驱动、平台支撑、服务增值、智能主导为特征的新智造发展，对增强制造业竞争优势，推动制造业高质量发展，加快建设制造强国、网络强国具有重要意义。

2.3.3 产业政策日趋完善 为智能制造保驾护航

近年来，我国出台了一系列推进智能制造发展的政策。其中，在国家层面，工信部公布《"十四五"智能制造发展规划》（征求意见稿）（以下简称：《发展规划》（征求意见稿））。

《发展规划》（征求意见稿）指出发展目标为，到 2025 年，规模以上制造业企业基本普及数字化，重点行业骨干企业初步实现智能转型。到 2035 年，规模以上制造业企业全面普及数字化，骨干企业基本实现智能转型。

《发展规划》（征求意见稿）提出的重点任务，包括加强关键核心技术攻关、加速系统集成技术突破、加快创新网络建设、开展智能制造示范工厂建设、加快行业数字化网络化发展、促进区域制造业数字化转型、大力发展智能制造装备、合力发展工业软件产品、着力打造系统解决方案、完善信息基础设施等。在地方层面，北京、上海、天津、广东等省市也相继出台推动智能制造发展的相关计划和规划，为今后一段时间的智能制造行业发展指明了方向。

在国家层面，工信部公布《"十四五"智能制造发展规划》（征求意见稿）（以下简称：《发展规划》（征求意见稿））。

通过梳理分析，我国智能制造相关政策具有以下主要特征：

推动技术创新。政策着力打造智能制造创新体系，鼓励智能制造创新平台建设，突破一批核心关键技术，实现部分技术达到国际先进水平，促进科技成果的转化。

注重重点领域的智能化发展。政策突出了新一代信息技术、高档数控机床与工业机器人、航空装备、船舶、先进轨道交通装备、节能与新能源汽车、电力装备、农业装备、新材料等领域的智能化。

着力培育智能制造生态系统。我国围绕智能制造应用、智能装备生产等方面，强化智能制造人才培养，完善政策环境，强化要素支撑，促进企业互利共赢，打造智能制造生态体系。

推进中小企业智能化转型。政策鼓励有基础、有条件的中小企业，积极开展数字化转型的试点应用；充分发挥大企业的带动作用；开展工业软件等外包服务。

加强标准体系建设。智能制造标准体系框架包括基础、安全、管理、检测评价、可靠性等基础共性标准和智能装备、智能工厂、智能服务、工业软件和大数据、工业互联网等关键技术标准。

强化核心动力与支撑。政策积极促进大数据、工业互联网、人工智能等产业的发展，为智能制造提供了良好的基础支撑。

财税金融支持力度大。政策加大政府财政资金支持力度，实施税收激励政策，采取多元化金融支持方式。

预计未来 10 年，机器人将代替全球 2000 万个制造业岗位，每一个新机器人进入劳动力市场，将平均有 1.6 名制造工人被替换。

2.4 中国智能制造在重点领域的发展情况

2.4.1 工业机器人

人力成本的上涨是推动制造行业机器换人的主要因素。同时，随着工业机器人国产化进程的加速带来了成本的下降。预计未来 10 年，机器人将代替全球 2000 万个制造业岗位，每一个新机器人进入劳动力市场，将平均有 1.6 名制造工人被替换。其中，中国已占据世界工业机器人应用数量的五分之一。到 2030 年，中国将有 1400 万机器人被投入使用，较世界其他地区处于领先地位。

2.4.2 工业互联网

智能制造可实现整个制造业价值链的智能化，而工业互联网是实现智能制造的关键基础设施。如今，作为推动制造业与互联网融合发展的重要抓手，工业互联网平台的理念和重要性逐渐被产业界所认识，全球各类产业主体积极布局工业互联网平台，以抢占发展制高点。在政策、技术等因素的推动下，中国已经出现一批工业互联网平台，产业体系已日趋完善。

2.4.3 人工智能 + 制造业

从制造业的角度出发，人工智能技术正在深入改造制造行业，新一代人工智能技术与制造业实体经济的深度融合，成为应用市场的一大亮点，催生了智能装备、智能工厂、智能服务等应用场景，创造出了一些新需求、新产业、新业态。

2.4.4 增材制造（3D 打印）

目前，以增材制造技术为代表的新一轮科技革命，正受到全球制造行业的广泛关注，世界各国纷纷把增材制造作为未来产业发展的新增长点，我国也从资金、政策等角度对增材制造产业的发展予以大力支持，尤其在发布《增材制造行业发展行动计划》后，我国增材制造服务产业及技术迎来了发展新契机。其中，3D 打印更是有望成为革新制造业的"新生力量"，其结合了大规模生产的高效和手工生产的灵活等优点，制造业全流程都可引入 3D 打印，能够实现制造过程的高效率和低成本，代表了智能制造的未来发展方向。

2.4.5 数字孪生技术

数字孪生在制造业的应用前景广阔。其中，产品的数字孪生应用覆盖产品的研发、工艺规划、制造、测试、运维等各个生命周期，可以帮助企业推进数字化营销和自助式服务，有助于企业提升维护服务收入，创新商业模式；工厂数字孪生在工厂设计、建造，生产线调试、安装，工厂运行监控、工业安全等方面都可以给企业带来价值；数字孪生在供应链管理领域也可以应用，例如车间物流调度、运输路径优化等。

三、推动中德智能制造领域务实合作的相关建议

1.加强政策对话，夯实共识互信。双方应充分发挥已有的沟通交流平

台机制，拓宽对话渠道，丰富交流方式，通过举行多层次交流对话，扩大利益交汇点，总结推广经验做法，切实增进双方共识，提升合作互信。双方应通过政策交流，改善营商环境，鼓励和支持中国企业在德开展互利合作，也欢迎德国企业来华投资兴业。

2.深化项目合作，推动产业升级。以中德智能制造合作试点示范项目为切入点，持续开展合作试点示范，拓展合作领域，加强在工业互联网、数字经济、人工智能、电动汽车等新兴产业和创新领域的试点示范项目遴选，围绕试点示范项目的经济效益和示范推广效果，加大对典型项目合作成果的宣传推广，扩大中德智能制造合作的覆盖面和影响力。此外，应该积极探索中德两国中小企业在智能制造领域的创新合作模式。

3.聚焦前沿领域，推动融合创新。中德应共同把握制造业未来发展脉搏，共同推动新一代信息技术在制造业等领域的融合应用。鼓励在新能源汽车、车联网、自动驾驶、智能制造、人工智能、数字化转型和5G等新兴前沿领域，积极开展互动交流，进一步拓宽中德两国企业合作空间。

四、借鉴德国工业 4.0 平台经验，推动我国制造业高质量发展

德国充分发挥政府统筹协调和引领作用，有效整合全国工业 4.0 资源，并构建了相配套、以工业 4.0 平台为代表的推进机制，有力推动了德国工业 4.0 的发展。

我国可借鉴德国经验，加快形成各类主体协同发力的体制机制，共同推动我国制造高质量发展。

1.德国政府充分发挥主导作用 统筹推进工业 4.0 战略实施

德国政府成立的工业 4.0 平台是负责推进工业 4.0 战略研究、政策制定、统筹协调及国际合作的专职机构，其包含 159 家机构、300 多名工作人员，是世界上最大、最多样的工作网络。该平台由德国联邦经济和能源部、教育和研究部共同领导，多个政府部门参与日常工作，形成了政府牵头组织推动、学术界提供咨询和技术支撑、协会工会创建平台、企业广泛参与的格局，有效推进了各界合作、对接，促进了跨领域、跨行业交流沟通。

该平台下设战略委员会、指导委员会、科学顾问委员会等机构。其中，战略委员会主要负责制定宏观政策和战略，统筹协调各方利益和诉求；指导委员会负责具体产业领域的技术合作，发展战略的制定和实施；科学顾问委员会负责把握重点领域和技术方向，并就重大关键问题提供咨询服务。德国工业 4.0 平台下设 6 个工作组，各组分别开展相关政策研究和实践部署。例如，行业协会和行动组负责市场化相关工作；国际标准化组负责相关领域标准的国际对接合作；此外，办公室负责沟通协调各个机构，统筹推进各项工作。这一平台及背后的运作机制，为德国工业 4.0 推进实施凝聚了强大合力。

2.凝聚社会力量参与 共推制造业高质量发展

德国政府高度重视社会力量参与，以工业 4.0 平台为纽带，紧密联结国内高校、科研院所、企业及协会等机构，并明确了不同主体在推进工业 4.0 进程中的定位。通过在平台下设立专门机构，实现了政府与学术界、产业界间的良好互动和反馈，企业遇到的各类实际问题能够快速传递给主管部门，成为政府优化和更新产业和创新政策的重要参考和依据。

总体来看，德国工业 4.0 更像是参与平台各方所达成的共识及行动纲领。相关主体围绕战略目标，结合分工定位协同发力，使得工业 4.0 快速获得社会广泛认同，并从工业领域渗透至社会生产生活各方面。

我国可借鉴德国经验，推动建立能够使社会各界资源有效对接的平台和机制，鼓励社会力量深度参与、有效互动，形成合力和共识，从而更好地推动我国制造业高质量发展。

3.完善推进体系 构建多方协同发力推动制造强国建设的机构体制

一是在体制机制方面，可在现有国家制造强国建设领导小组基础上，建立制造强国建设推进平台，吸纳相关企业、科研院所及协会，推动完善我国制造业高质量发展的顶层设计。例如，可基于制造强国建设推进平台，围绕智能制造、绿色制造、标准规范、人才培养、数据安全等重点领域，设立专项工作组，由相关部委牵头运行，充分调动相关领域社会力量，推

德国政府高度重视社会力量参与，以工业 4.0 平台为纽带，紧密联结国内高德国政府高度重视社会力量参与，以工业 4.0 平台为纽带，紧密联结国内高校、科研院所、企业及协会等机构，并明确了不同主体在推进工业 4.0 进程中的定位。

进具体工作。例如，可考虑成立技术咨询委员会，建立负责产业技术发展的常设机构，重点攻关我国关键共性技术和产业前沿技术突破，不断增强产业创新能力。

二是在产业政策方面，主管部门在制定支持制造业高质量发展政策体系时，既要注重中央与地方产业政策的纵向贯通，也要注重不同部门间政策的横向衔接，有效凝聚各地区各部门共识、有效促进相关资源要素高效配置。

三是在法律法规方面，探索通过立法引领产业发展，不断完善财税金融、知识产权、人才培养等配套政策法规体系，促进制造业长期稳定发展。

I. Background

Since Joint Program of Action on Cooperation: Shaping Innovation Together was signed in November 2014, the cooperation framework between China and Germany has been basically established. Our cooperation shows a positive outlook with improved working mechanism, deepening bilateral exchanges and more project cooperation. At present, Sino-German cooperation continues to make new progress, laying the foundation for advancing pragmatic collaboration between us. Governments have built enterprise-led mechanisms for bringing together firms, universities and research institutes to engage in cooperation. Our cooperation is progressing well in many areas among which intelligent manufacturing is the focus.

The Memorandum of Understanding on Sino-German Enterprise Cooperation in Intelligent Manufacturing and Networking of Production Process by the Ministry of Industry and Information Technology of the People's Republic of China and the German Federal Ministry for Economic Affairs and Energy (hereinafter referred to as the Memorandum of Understanding) was signed in July 2015. The goal is to implement the consensus between both leaders and to strengthen cooperation in policies, industries and innovation in the Industrie 4.0 and the digital and intelligent development of manufacturing industry.

In October 2015, China and Germany held the first working group meeting, in which two sides reached a lot of consensus in building exchange mechanisms and pilot demonstration projects of intelligent manufacturing, promoting standardization of intelligent manufacturing, and conducting cooperation among small and medium-sized enterprises, personnel training and forward-looking research. This meeting marks the initial establishment of a regular working mechanism for promoting smart manufacturing cooperation between the two countries. In accordance with the requirements of the Memo-

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randum of Understanding, the two countries have established three levels of joint working mechanisms: the first level is a mechanism for vice—ministerial dialogue that determines the annual vice—ministerial meetings to be held alternately in China and Germany; the second level is the dialogue mechanism at the bureau level; the third level is the docking mechanism of executive platform which means that each government of the two countries designates an executive platform to be responsible for communication on technical issues between enterprises. On April 9, 2019, Alliance for Sino—German Intelligent Manufacturing was established in Shenzhen, acting as an important platform to connect the strategy of "Manufacturing Power" and German "Industrie 4.0".

Thanks to this working mechanism on cooperation, representatives of enterprises, industry organizations, experts and scholars from all walks of life of the two countries have gathered to build many exchange platforms like industrial cooperation working groups, standardization working groups and scientific research working groups. The cooperation has been fruitful. On industrial cooperation, 54 pilot demonstration projects were selected in 5 batches. In the field of technical exchanges, the two countries have strengthened technical exchanges and cooperation in high—end equipment, additive manufacturing, new energy, new energy vehicles and key parts and components. The two countries have established a good basis for cooperation in such areas as automobiles, photovoltaic, construction machinery, electric power equipment, rail transit, energy conservation and environmental protection. Since its establishment six years ago, the cooperation mechanism has played an important role in promoting Sino—German cooperation on intelligent manufacturing and networking of production process. It has been highly commended and actively participated in by all sectors in both societies

II. The status quo and future directions in the development of German "Industrie 4.0" and Chinese intelligent

Germany is known for its strong industrial capabilities. In order to maintain its leading position in manufacturing and improve productivity.

manufacturing

1. The status quo and future directions in the development of German "Industrie 4.0"

Germany is known for its strong industrial capabilities. In order to maintain its leading position in manufacturing and improve productivity, the German government has proposed the concept of "German Industrie 4.0", which refers to the fourth industrial revolution. The aim is to improve efficiency, reduce costs, and speed up response time through establishing an intelligent and advanced manufacturing method integrated with the Internet, thus guaranteeing the global leadership of "Made in Germany".

1.1 Status quo and problems

The German Plattform Industrie 4.0 is the main body to implement the German Industrie 4.0 strategy. The participants of the platform can be divided into three categories: government, companies, and educational and research institutions. The government is in charge of providing the policy framework and promoting cooperation: the educational and research institutions are responsible for providing the theoretical foundation for identifying the initiatives and development directions; and the companies are the practitioners of this strategy.

While Germany is optimistic about achieving the goals of this strategy, it also saw with clarity that many challenges still exist in the digital transformation process. These are shown in three main aspects. Firstly, IT construction and application have a stronger development at the enterprise level but remain weaker in society as a whole. Secondly, small and medium sized enterprises still lack solutions to complex problems in the digital era. Thirdly, there is a big gap between domestic innovation of business model and that in leading countries.

1.2 Achievements and advantages

Nowadays, this platform has made many achievements.

It disseminates knowledge and information. The online library brings to－gether content such as relevant government strategy documents and research re－sults from the platform＇s working groups.

The user cases focus on examples of various types of companies in Ger－many using this platform to solve problems.

It provides support from many aspects for companies to conduct test pro－jects. The platform lists in detail more than 500 locations throughout Germany where relevant tests can be carried out so that companies can easily access rele－vant resources. With the support of the German Federal Ministry of Education and Research, the platform can advise SMEs on selecting the appropriate test－beds for their specific projects and can also provide funding to these com－panies.

It carries out extensive international cooperation. The platform has estab－lished contacts or proposed cooperation plans with major countries such as the United States, China, France and Japan, in an effort to make Industrie 4.0 a ＂global issue＂ and to facilitate the entering of local companies into interna－tional markets.

Its leading advantages are shown in the following ways.

The practitioners of Industrie 4.0 are the companies, especially those in the German manufacturing industry which has now formed a scale effect and is the core force of industries development.

Germany is clearly more competitive in providing technologies and solu－tions for Industrie 4.0. There are already several leading companies that have advantages of group practice in many high－end fields and parts, especially the multinational companies. For example, Siemens＇ ＂Digital Enterprise Plat－form＂ system provides a carrier for digital manufacturing; BMW Group＇s virtual gesture recognition system has taken automobile manufacturing to the next level development; Volkswagen uses robots to manufacture cars, optimizing efficiency by replacing human workers; ABB＇s powerful, sophisticated and

comprehensive robot products have a sharp competitive edge in the world; Bosch promotes the RF code system for achieving factory intelligence; SAP promotes the cloud platform to interconnect everything and supports decision making based on big data.

In the technological and industrial transformation of Industrie 4.0, large businesses, especially multinational companies, play the leading role, but a large number of small and medium-sized enterprises are also valued by the German government who provides public services to them. SMEs, mainly family enterprises, are also known as the "inheritors of the craftsman spirit". These German companies do not pursue mass production, but are known for their "expertise". Although a significant number of German SMEs are still skeptical or adopt a wait-and-see attitude about digital transformation, Industrie 4.0 ensures the participation of SMEs. For example, the Federation of German Industries is an important participant in the platform and also represents the interests of more than 100,000 enterprise members. Plattform Industrie 4.0 provides information, testing, financial and other support for SMEs, and dispels their concerns with practical examples.

2. Status quo and future directions in the development of Chinese intelligent manufacturing

Intelligent manufacturing is a new manufacturing form with self-awareness, self-learning, self-decision-making, self-execution, self-adaptation and other functions

Intelligent manufacturing is a new manufacturing form with self-awareness, self-learning, self-decision-making, self-execution, self-adaptation and other functions. It combines the new generation of information technology with advanced manufacturing technologies and covers all aspects of manufacturing activities including design, production, management, service and others. Accelerating the development of intelligent manufacturing is necessary for China to foster new drivers of economic growth and stay ahead of the curve in global economic and technological competition in the future. It has strategic significance for promoting the supply-side structural reform of China's manufacturing in-

dustry, creating new competitive advantages in China's manufacturing indus-try, and realizing the goal of becoming an "Manufacturing Power".

2.1 China's manufacturing industry has steadily grown

In recent years, China's economy has shifted from high-speed growth to high-quality development. The Chinese economy has entered a "new nor-mal" that is different from the high-speed growth pattern exhibited in the past. Although the proportion of manufacturing value added in China's GDP is on the decline, the real economy represented by the manufacturing sector is the key to the high-quality development of China's economy.

2.2 China's intelligent manufacturing capabilities are relatively weak and manufacturing industrial upgrading is needed

At present, China's manufacturing industry is still in the late stage of the second industrial revolution □ Industry 2.0 with electrification as the main feature. It has many problems like relatively weak quality foundation, unreason-able industrial structure, low utilization rate of resources, low level of industry informatization, and increased labor costs.

First, China still lags behind in putting forward basic theories and con-structing technology system of intelligent manufacturing. At present, China fo-cuses on intelligent tracking technologies in manufacturing and technology in-troduction. However, it still needs to improve its insufficient basic research ca-pability and weak absorption of the introduced technology. It lacks original in-novation, has incomplete technical system, and remains weak in key technolo-gies like control system and system software.

Second, the digital foundation for the development of intelligent manufac-turing in China is relatively weak, and the development of the manufacturing industry as a whole is still in the transition stage from mechanical automation to digital automation. If the German Industrie 4.0 is taken as a reference, it is re-garded that China is still in the Industry 2.0 era on the whole with some en-terprises moving towards the Industry 3.0 era.

At present, China's manufacturing industry is still in the late stage of the second industrial revolution Industry 2.0 with electrification as the main feature.

Third, we rely on others for the key technologies and core components. We have less than 5% of market share in high-end sensors, intelligent instrumentation, high-grade numerical control system and industrial application software. Large construction machinery required more than 30Mpa hydraulic parts are all imported and imported components account for 50%-60% of the total value of the large loaders.

Fourth, the lack of high-end software products. The integration of industrialization and information technology in China's manufacturing industry is relatively low. Low-end CAD software and corporate management software are well popularized. However, there are not enough high-end intelligent software used in the design of complex products and corporate management.

Fifth, the system integration ability of enterprises is relatively weak, and large international enterprises are insufficient.

2.3 Driving forces for the development of China's intelligent manufacturing

2.3.1 Rising labor costs are driving the transformation and upgrading of the manufacturing industry

Manufacturing is a labor-intensive industry. But now China's elderly population is larger than any other country in the world and far exceeds the average standard. Since 2000, China has become an aging society, with its aging population growing more hugely and more rapidly. According to statistics from the National Bureau of Statistics, the number of people aged 60 years and above in China was 250 million in 2018, accounting for 17.9% of the total population. It is estimated that the number of the elderly population will reach 500 million by 2050.

Due to the accelerated population aging, the supply of labor force in China is decreasing. The sharp decline of labor force leads to the rise of labor costs. Since the 21st century, the average wage in China's manufacturing industry has been increasing year by year and growth rate is speeding up, which

gradually counteracts China's labor cost advantage. In the fourth manufacturing shift, labor−intensive low−end industries tended to move to Southeast Asian countries where labor costs are lower and environmental protection requirements are looser, while the demand for automated and intelligent production in some middle and high−end industries tended to return to Europe and the United States. China's manufacturing industry is facing pressure in two aspects. Therefore, the decline of labor force and the rise of la−bor costs facilitate the intelligent automation of the manufacturing industry. In−telligent manufacturing can replace human labor and even enhance people's ability by increasing their productivity. These are the development trends of the manufacturing industry in the future.

2.3.2 Continuous innovation of new information technology drives the shift from traditional manufacturing to intelligent manufacturing

Currently, the growth of traditional manufacturing has slowed down, while high−tech manufacturing continues to grow rapidly, especially the digital econ−omy. The digital dividends of smart and digital technologies and the Internet in the manufacturing industry have created a number of opportunities for the development of the industry in the future.

New information technologies, including big data, cloud computing, artificial intelligence, Internet of Things, 5G and block chain, are applied more extensively to research and development, production and manufacturing, operation and management, maintenance and other services in enterprises. Manufacturing is gradually driven by data rather than process. The focus of the integration of industrialization and information technology is shifting from single application to integrated and collaborative innovation. It is essential to accelerate the development of software−defined, data−driven, platform−supported, service value−added and intelligence−based new intelligent manufacturing to promote the competitive advantage and high−quality development of the manufacturing industry and build a manufacturing and cyber power.

2.3.3 More comprehensive industrial policies spur the development of intelligent manufacturing

In recent years, China has adopted a series of policies to promote the development of intelligent manufacturing. At the national level, the Ministry of Industry and Information Technology launched the 14th Five−Year Plan for the Development of Intelligent Manufacturing (Exposure Draft) (hereinafter referred to as the "Development Plan (Exposure Draft)").

The Development Plan (Exposure Draft) proposes that by 2025, digitalization in manufacturing enterprises above designated size will be basically realized, and major enterprises in key industries will initially realize intelligent transformation. By 2035, digitalization will be realized in all manufacturing enterprises above designated size, and the major enterprises will basically realize intelligent transformation.

The key tasks proposed in the Development Plan (Exposure Draft) include strengthening the research of core technologies, speeding up technological breakthroughs of system integration, accelerating the innovation of network building, promoting the building of demonstration factories of intelligent man−ufacturing, stepping up the development of digital network in the manufactur−ing industry, facilitating the digital transformation of regional manufacturing, developing the intelligent manufacturing equipment and industrial software products, working on effective solutions, and improving information infrastruc−ture. At the local level, Beijing, Shanghai, Tianjin, Guangdong and other provinces and cities have also introduced relevant plans to promote the devel−opment of intelligent manufacturing, charting the course for the development of intelligent manufacturing in the future.

Through a detailed analysis, China's policies of intelligent manufacturing have the following characteristics:

Driving technological innovation. The policies focus on building innova−tion system and platform for intelligent manufacturing, making breakthroughs in

Focusing on the intelligent development of key areas. The policies highlight the intelligent development in areas like new information technologies.

a number of core technologies, bringing some of these technologies to the international level, and promoting the application of scientific and technological achievements.

Focusing on the intelligent development of key areas. The policies highlight the intelligent development in areas like new information technologies, high-end CNC machine tools and industrial robots, aviation equipment, ships, advanced rail transit equipment, energy saving and new energy vehicles, electrical equipment, agricultural equipment and new materials.

Creating an ecosystem for intelligent manufacturing. China focuses on the application of intelligent manufacturing and the production of intelligent equipment to strengthen the training of talents for intelligent manufacturing, improve the policy environment, step up the support of factors, promote mutual benefits for enterprises, and create an ecosystem for intelligent manufacturing.

Facilitating the intelligent transformation of small and medium-sized enterprises. The policies encourage small and medium-sized enterprises with financial support to carry out pilot projects to promote digital transformation. The policies also encourage large enterprises to give full play to their leading role and launch outsourcing services including the industrial software.

Strengthening the development of the standards system. The standards system of intelligent manufacturing includes basic common standards on the basis, safety, management, testing, evaluation and reliability, and key technical standards on intelligent equipment, intelligent factory, intelligent service, industrial software, big data and industrial Internet.

Stepping up core driving force and support. The policies promote the development of big data, industrial Internet, artificial intelligence and other industries, laying a solid foundation for the development of intelligent manufacturing.

Enhancing fiscal, taxation and financial support. The policies increase

Enhancing fiscal, taxation and financial support. The policies increase financial support from the government, implement tax incentive initiatives, and adopt diversified methods to provide financial support.

financial support from the government, implement tax incentive initiatives, and adopt diversified methods to provide financial support.

2.4 Development of China＇s intelligent manufacturing in key fields

2.4.1 Industrial Robots

The rise in labor costs is the main factor of the replacement of machines for humans in the manufacturing industry. At the same time, with the acceleration of the popularization of industrial robots in domestic market, the costs have been reduced. It is expected that robots will replace 20 million manufacturing jobs worldwide over the next decade, with an average of 1.6 manufacturing workers being replaced for every new robot in the labor market. The industrial robots China has used account for one fifth of the world＇s total. By 2030, China will put 14 million robots into use, surpassing the rest of the world.

2.4.2 Industrial Internet

Intelligent manufacturing ensures that the whole manufacturing value chain is intelligent. The industrial Internet is the key infrastructure to realize intelligent manufacturing. Today, as a key driving force to promote the integration of the manufacturing industry and the Internet, the platform of industrial Internet has been gradually recognized and valued by the industry. Various industrial entities around the world are working on the industrial Internet platform to seize the competitive advantage of development. Thanks to relevant policies and technologies, a number of industrial Internet platforms have emerged in China, and the industrial system has been gradually improved.

2.4.3 Artificial Intelligence and Manufacturing

From the perspective of manufacturing, AI technology is transforming the manufacturing industry, and new AI technology is deeply integrated with the real economy, which becomes a highlight of the application market and demonstrates new requirements, new industries and new business forms of the automation created by application scenarios such as intelligent equipment,

intelligent factories and intelligent services.

2.4.4 Additive Manufacturing (3D Printing)

At present, a new round of technological revolution represented by additive manufacturing is attracting extensive attention from the global manufacturing industry. Countries around the world have considered it as a new growth area of this industry in the future. China also provides great financial and policy support for the development of additive manufacturing. After issuing the Action Plan of the Development of Additive Manufacturing, China has ushered in new opportunities to promote the development of services and technologies in additive manufacturing.

Among them, 3D printing is expected to become a "new driving force" to innovate the manufacturing industry. Combining the advantages of high efficiency of mass production and flexible manual production, 3D printing can be introduced to the whole manufacturing process while ensuring high efficiency and low costs. This represents the development course of intelligent manufacturing in the future.

2.4.5 Digital Twin Technology

Digital twin technology is widely applied to the manufacturing industry, including the product R&D, technical planning, manufacturing, testing, operation, maintenance and other production cycles, which can help enterprises promote digital marketing and self-service services, increase the income of maintenance services and innovate business models. Digital twin can bring value to enterprises in factory design and building, production line debugging and installation, factory operation monitoring, and industrial safety. Digital twin technology can also be applied to supply chain management, such as workshop logistics dispatch and the optimization of transportation routes.

III. Suggestions on promoting practical cooperation of Sino−German intelligent manufacturing

1. Strengthen policy dialogue and cement consensus and mutual trust. The two sides should give full play to the existing exchange mechanism, expand the channels of dialogue, and enrich the ways of communication. Through multi−level exchanges and dialogues, the two sides should expand areas of converging interests, summarize and share experience, and enhance bilateral consensus, cooperation and mutual trust. The two sides should promote policy exchanges to improve the business environment, encourage Chinese enterprises to strengthen win−win cooperation in Germany, and also welcome German enterprises to invest in China.

2. Deepen project cooperation and promote industrial upgrading. Focusing on pilot demonstration projects of Sino−German intelligent manufacturing cooperation, the two sides should continue to implement pilot demonstration, expand areas of cooperation and strengthen the pilot project selection in emerging industries and like the industrial Internet, digital economy, artificial intelligence, electric cars and other innovation areas. The two sides should also highlight the economic benefit and the promotion effect of pilot demonstration projects, and publicize the benefits of typical project cooperation, so as to expand the areas and influence of Sino−German cooperation in intelligent manufacturing.

3. Focus on cutting−edge sectors and promote integrated innovation. China and Germany should grasp the opportunities of the future development of the manufacturing industry and promote integrated application of new information technology. The two sides should encourage mutual exchanges in emerging frontier areas, including new energy vehicles, Internet of Vehicles, autonomous driving, intelligent manufacturing, artificial intelligence, digital transformation and 5G, to further expand cooperation between Chinese and

Focusing on the intelligent development of key areas. The policies highlight the intelligent development in areas like new information technologies.

German companies.

IV. Building a system to promote the high−quality development of China's manufacturing industry by drawing on the experience of German Plattform Industrie 4.0

Sound promotion system and working mechanism are the key to guarantee the practical effect of planning policies. Through field research and analysis, it is found that Germany has given full play to the overall coordination and leading role of the government. While releasing a series of strategic plans and industrial policies in manufacturing, Germany has also built a promotion mechanism, represented by the Plattform Industrie 4.0, to mobilize private sectors to participate in the implementation of the platform. We should learn from the experience of Germany, speed up the improvement of China's industrial development promotion system and mechanism, and form a strong synergy of various entities to jointly support the high−quality development of manufacturing.

1.The German government playing a leading role in promoting Industrie 4.0

The government emphasizes the in−depth participation of society, sets up the Plattform Industrie 4.0 and takes the lead to coordinate various entities to jointly promote the implementation of the Industrie 4.0 strategy. Germany has established a government−led cross−border professional organization to promote Industrie 4.0, i.e. Plattform Industrie 4.0, which is responsible for strategic research, policymaking, overall coordination and international cooperation. It is composed of 159 organizations and more than 300 staff and has become the largest and most diverse industrial network in the world. The platform is jointly led by the Federal Ministry for Economic Affairs and Energy and Federal

The government emphasizes the in−depth participation of society, sets up the Plattform Industrie 4.0 and takes the lead to coordinate various entities to jointly promote the implementation of the Industrie 4.0 strategy.

Ministry of Education and Research, with various government departments participating in daily work. Therefore, it forms a pattern in which the government takes the lead in organizing and promoting, academia provides advice and technology support, associations and unions create a platform, and enterprises participate extensively. This pattern realizes the cooperation and connection among all walks of life, and effectively promotes the interdisciplinary and cross-industry communication.

Under the platform, there are several bodies with the participation of various parties. The strategy council, headed by the Secretary of State, is responsible for formulating macro policies and strategies, and coordinating the interests and demands of various parties. The steering committee is responsible for technology cooperation in specific industries, as well as the formulation and implementation of development strategies.

The scientific advisory board is responsible for identifying priorities and technologies and providing advisory services on key issues. There are six working groups under the platform, covering topics such as standards and norms, research and innovation, cyber security, legal framework, employment education and training, and other needs. Although they carry out related policy research and practical deployment respectively, the working groups have clear division of labor while emphasize mutual cooperation. Industry associations and action groups are responsible for market-based tasks. The international standardization group is responsible for international cooperation of standards in relevant fields. In addition, the office is responsible for communicating and coordinating with various agencies, as well as organizing and promoting various work. The platform and its operation mechanism help define the positioning and functions of each participant, establish the consensus that Germany is an industrial power and has an advantage of prospective product and market competition, and pool the strong joint force of clear division of labor and mutual cooperation to promote Industrie 4.0.

2. Mobilizing participation of society is the key to promoting high-quality development of manufacturing

According to Germany's experience, the promotion mechanism based on consensus, division of labor and cooperation of all parties are the key to guarantee the implementation of Industrie 4.0. The German government attaches great importance to give full play to the major role of social forces. Plattform Industrie 4.0 is a perfect example that features in-depth participation of the government and close cooperation of institutes and universities, enterprises and associations. Under this platform, the discourse system of various stakeholders has been built and all the participants are clear about their own position and tasks in advancing the Industrie 4.0. For example, the committees of the platform have realized good interaction and feedback between the government, academia and industry, so that scientific research results and practical problems encountered by enterprises can be timely transmitted to the government, and the government, in turn, can optimize and update industrial and innovation policies.

At the same time, the platform also gives out the information, including government strategy documents, working group research results, and cases of applying Industrie 4.0 solutions to tackle problems, to enterprises and the public in a timely manner. Industrie 4.0 is not only a strategy or a vision, but also an action program for all parties to reach consensus and make joint efforts. All kinds of participants focus on the strategic goals, combine the division of labor with their own positions to make concerted efforts, so that Industrie 4.0 is quickly recognized by the whole society and permeates into all aspects of social production and life by means of industrial field.

In China, the system for promoting high-quality development of the manufacturing industry is not flawless, and there is an urgent need to set up a platform and mechanism for effectively connecting resources from all walks of

life. At present, Chinese government, enterprises, associations, research institutes, etc., do not have clear responsibilities to promote the development of manufacturing. In addition, there is a lack of a platform for connection and long-term mechanism that cover all sectors, and therefore in the formulation and implementation of policies, it is difficult to deliver actual effect. On the other hand, the government has done a great deal of work that should not be promoted by the government. This has made it difficult to realize the effective interaction of all sectors of society and is not conducive to achieving consensus and synergy. The government has done all the work on its own more often than not. As a result, other parties cannot participate when they should have played a part, which puts the government on a passive position when it comes to international cooperation.

3. To improve the promotion system as the starting point to form a strong joint force to support the high-quality development of manufacturing

It is necessary to improve the promotion system and include various entities to establish a platform for promoting China as a manufacturing power. It is also important to clarify the positioning and functions of various entities in developing the manufacturing industry, and build a promotion organization and system for all parties to join forces in a concerted effort.

3.1 On the basis of existing leading group for building a manufacturing power, we will establish a platform that includes enterprises, research institutes and associations to build China into a manufacturing power. The platform will take overall responsibility for top-level design of high-quality development of manufacturing. All participants will work together and fulfill their respective responsibilities in key tasks and major projects.

3.2 Focus on key areas such as intelligent manufacturing, green manufacturing, standards and norms, talent training, data security, etc. A

To improve the promotion system as the starting point to form a strong joint force to support the high quality development of manuf-acturing.

number of special working groups are set up under the platform, which is led by relevant ministries and commissions, to strengthen coordination at the ministerial level and to mobilize social forces in relevant fields to jointly promote specific work.

3.3 Establish a technology advisory committee. Based on the National Manufacturing Strategy Advisory Committee, a permanent institution responsible for the development of industrial technologies will be established to identify the key generic technologies and cutting—edge industrial technologies that China should make breakthroughs in the future, and identify the institutions that should be relied on to make breakthroughs in these technologies.

3.4 Give full play to associations. We should encourage the transformation and development of associations, actively connect with the platform, enhance the service coordination ability, play a greater role in information collection and sharing, industry standard formulation, inspection and testing, etc., and build a bridge between enterprises, universities and institutions, and the government, so as to effectively meet the demands of enterprises. We will strengthen department coordination and establish a system of policies and regulations to support high—quality development of manufacturing.

As for policy, industrial departments should take the lead in designing a policy system to support high—quality development of manufacturing.

As for policy, industrial departments should take the lead in designing a policy system to support high—quality development of manufacturing. We should not only pay attention to the vertical connection of the central and local governments' industrial policies, but also emphasize the horizontal linkage of policies between different departments, so as to create a situation where all regions and departments build consensus and promote the efficient allocation of resource factors with each playing its own role. Enterprises, universities, research institutes, industry associations and other stakeholders will be included in the formulation and implementation of policies to further stimulate the enthusiasm and motivation of all sectors to participate in making China a

manufacturing power.

In terms of laws and regulations, we should promote industry development through legislation and speed up the legislation of key areas and industries. We should also update rules and normative documents according to new situations and changes, and constantly improve supporting policies and regulation system in taxation, finance, intellectual property and personnel training. We need to enhance effective investment, formulate laws and regulations in managing high quality resources, establish our confidence in promoting the long-term and steady development of manufacturing.

In addition, supervision, inspection and third-party evaluation should be strengthened to timely discover problems in the implementation of policies and regulations, such as inter-department restraint, not being realistic, difficulties in implementing and ineffective work, and make timely adjustment and improvement to ensure that policies and measures are put in place.

案例篇
Cases

广汽乘用车：打造智能制造标杆工厂

在选购汽车时，你最看重的是什么？安全评级、外观内饰还是动力操控？成年人不做选择题，全都要。

面对越来越多元化、高标准的消费者需求，汽车制造企业一直致力于科技创新和标准升级。人工智能、虚拟仿真、边缘计算、物联网……在这满满的"黑科技"背后，是企业对品质的永恒追求。

广汽乘用车有限公司(广汽乘用车)是广汽集团设立的全资子公司。一直以来，公司围绕高质量发展理念，不断应用创新科技来激活生产潜力和完善质量体系。通过与西门子合作，广汽乘用车在智能制造领域又一次实现突破——打造出一座高效率、高质量、节能环保的世界级数字化工厂。

广汽乘用车有限公司宜昌分公司副总经理张少伟说："宜昌基地汇聚了行业领先的自动化生产工艺和数字化技术，将'工业4.0'理念与创新生产方式落到实处。在工厂的建设和运营过程中，西门子以软硬件一体的数字化企业解决方案和专用于汽车行业 Si-car 标准，为我们提供了强有力的支持，与我们共同致力于智能制造愿景的实现。"

修炼内功，树立智能制造新标杆

2019 年 6 月 28 日，广汽乘用车宜昌工厂首款产品车下线，标志着极限速度可达 52 秒下线一辆新车的生产线正式竣工投产。

在这座总占地面积约 1400 亩的大型工厂里，西门子全集成自动化(TIA)技术遍布冲压、焊装、涂装、总装、合成树脂等各大车间，PLC、HMI 和工业通信等产品以其高可靠性保障稳定、高效的汽车生产。

同时，西门子工业软件也为工厂构筑了坚实的数字化基础。在研发阶段，西门子仿真和试验解决方案平台 Simcenter 可以创建切实有效的"数字化双胞胎"，为汽车产品的振动、噪声、燃油经济性、自动驾驶性能等关键领域的开发提供强大的平台支撑。在生产阶段，基于西门子制造运营管理

广汽乘用车有限公司宜昌分公司副总经理张少伟说："宜昌基地汇聚了行业领先的自动化生产工艺和数字化技术，将'工业4.0'理念与创新生产方式落到实处。

平台 Opcenter，管理人员能够对订单分配、批次处理、质量控制和库存管理等制造流程进行全方位的数字化管控，凭借端到端的生产可见性，轻松找出需要优化的部分并灵活调整生产策略。

精工细作，边缘 AI 严守质量关

在汽车的制造过程中，焊接质量检测是一项精细而复杂的任务。每辆汽车的"白车身"主体结构约有 2000 到 3000 个不同类型的焊点，其焊接质量直接关乎汽车的整体安全和使用寿命。目前最为常见的检测方法是使用便携式超声波仪器进行抽检。此外，工厂也会定期抽样，采取凿检甚至整车撕裂的破坏性检测方式。虽然多种抽检方法相结合能够降低问题车辆出现的概率，但无法从根本上杜绝白车身不合格的隐患。

广汽乘用车宜昌工厂的焊接车间自动化率达 100%。出于对质量的极致追求，广汽乘用车将西门子独特的工业人工智能软件应用于车间核心工站，实现了生产过程中的焊接质量预测。基于机器学习算法和边缘计算技术，软件系统可以对焊接执行工艺的数据进行实时分析，根据参数变化对每个焊点的质量给出预测结果。

由此，工作人员就可以对潜在缺陷焊点进行定向检测，不但可以更精准地排查隐患，还能大大降低人力和设备成本。随着应用规模的扩大和数据量的增加，人工智能软件将不断地自我学习，在质量预测的基础上进一步实现对焊接参数的智能优化，最终消除缺陷焊点。

未来，广汽乘用车将继续发挥人工智能的优势，在焊接工站核心系统预测性维护和涂装 车间工艺优化等方面与西门子携手共创。

未来，广汽乘用车将继续发挥人工智能的优势，在焊接工站核心系统预测性维护和涂装 车间工艺优化等方面与西门子携手共创。

改变的是科技，不变的是初心。在广汽乘用车的宜昌数字化工厂里，智能制造"黑科技"正赋予工匠精神新内涵。在当代新型城市的发展进程中，以汽车产业为代表的更多先进制造基地正落地生根，依托数字化技术为推进行业可持续发展和打造智慧城市提供新动能。

西门子(中国)有限公司工厂自动化事业部战略和产品管理总监莫瑞茨(Moritz Mauer)说："许多在消费市场已经大放异彩的创新科技，正在越来越多地应用于工业领域。当然，企业进行数字化转型的意义不在于酷炫的技

GAC Motor: Commit to Building a Model Factory of Intelligent Manufacturing

What do you value most when purchasing a car? Security, exterior appearance and interior decorations, or power control? We adults do no multiple choices questions. We want them all.

In the face of increasingly diverse and high-standard demands of consumers, automotive manufacturers have been committed to technological innovation and standard upgrades. The "black technologies" of artificial intelligence, virtual simulation, edge computing, Internet of Things, etc. are the manifestations of their eternal pursuit of quality.

Guangzhou Automobile Group Motor Co., Ltd. (GAC Motor) is a wholly-owned subsidiary of GAC Group. The company has been focusing on the concept of high-quality development and continuously applying innovative technologies to activate the production potential and improve the quality system. Through the cooperation with Siemens, GAC Motor has achieved another breakthrough in the field of intelligent manufacturing—creating a world-class digital factory with high efficiency, high quality, low cost of energy and environmental protection.

Zhang Shaowei, Deputy General Manager of Yichang Branch of GAC Motor, said, "The Yichang base brings together the industry's leading automated production processes and digital technologies to put the 'Industry 4.0' concept and innovative production methods into practice. During the construction and operation of the factory, Siemens has supported us with their digital enterprise solutions integrating software and hardware and Si-car standards specially used for the automotive industry to help us realize our vision of intelligent manufacturing."

Enhancing self-capabilities to set a model for intelligent manufacturing

On June 28, 2019, the first commodity vehicle in Yichang factory of GAC Motor rolled off the production line, marking the completion of the production line with a limit speed of 52 seconds to roll off a new vehicle.

In this large-scale plant covering a total area of about 1400 acres, Siemens' Totally Integrated Automation (TIA) solutions are used in the major workshops of stamping, welding, painting, final assembly and synthetic resin, etc. Products such as PLC, HMI and industrial communication guarantee stable and efficient vehicle production with their high reliability.

At the same time, Siemens industrial software has also built a solid digital foundation for the factory. In the R&D stage, Simcenter, a Siemens simulation and test solution platform, has created "digital twins" to strongly support the development of key areas such as vibration, noise, fuel economy and self-driving performance of automotive products by the powerful platform. In the production phase, based on Opcenter, the Siemens manufacturing operations management platform, managers can digitally control all aspects of the manufacturing process such as order allocation, batch processing, quality control and inventory management, and easily identify parts that need optimization and flexibly adjust production strategies with end-to-end production visibility.

Elaborate manufacturing by Edge AI to ensure quality

Welding quality inspection is a delicate and complex task in manufacturing automobiles. The main "body-in-white" structure of each car has about 2000 to 3000 different types of welding joints, and the welding quality of them is directly related to the overall safety and service life of the car. The most common method of inspection is random testing using portable ultrasonic instruments. In addition, chisel inspection or even the whole car tearing destructive testing methods are used during regular sampling. Although the combination of various sampling methods

can reduce the probability of problem cars, it is not possible to eliminate the potential risks of unqualified body−in−white.

The automation rate of the welding workshop in Yichang factory of GAC Motor has reached 100%. Out of the ultimate pursuit of quality, GAC Motor has applied Siemens' unique industrial artificial intelligence software to the core work stations in the workshop for welding quality prediction during the production process. On the basis of machine learning algorithms and edge computing technology, the software system can analyze data from the welding execution process in real time and give predicted results for the quality of each weld joint based on parameter changes.

As a result, staff can perform targeted detection of potentially defective welding joints, which not only allows for more accurate identification of hidden problems, but also significantly reduces labor and equipment costs. As the scale of application and the amount of data increases, the AI software will continue to learn from itself, further optimizing the welding parameters based on quality prediction and ultimately eliminating defective welding joints.

In the future, GAC Motor will continue to take advantage of artificial intelligence and work hand in hand with Siemens in the areas of predictive maintenance of core systems in welding stations and process optimization in painting workshops.

The technology is evolving, but our original aspiration remains unchanged. In the digital factory of Yichang of GAC Motor, craftmanship has been given new meanings by the "black technologies" of intelligent manufacturing. In the development of the new urban cities, more advanced manufacturing bases represented by the automotive industry are taking root. By digital technologies, they are providing new momentum to the sustainable development of the industry and the construction of smart cities.

Moritz Mauer, director of Strategy and Product Management of Industrial Automation Division in Siemens (China) Ltd., said: "Many of the innovative

The automation rate of the welding workshop in Yichang factory of GAC Motor has reached 100%.

technologies that have already made a splash in the consumer market are increasingly being applied in industry. Of course, digital transformation for companies is not about cool technology, but about delivering practical value. Siemens has the vertical expertise to understand the specific needs of its customers and is working together with Chinese companies to unlock the unlimited potential of innovative technologies in the industrial sector."

Many of the innovative technologies that have already made a splash in the consumer market are increasingly being applied in industry.

东风装备：从技术使能到价值赋能

在东风装备举办的一场实地参观活动中，给人留下的直接印象是碎片化的，因为看到了一个一个不同的点，无论是基于 SaaS 的质量管控系统、多种功能配置的在线综合测量仪、能够实时传输数据的便携式电子塞规和卡规，还是来自 APP 端的操作管控和数据显示、基于 ERP、MES 的演示操作、全流程的产品追溯等。

从经营管理到工业现场 数字化转型的顺序不能乱

如今东风装备的"数字装备"项目已经进入了 2.0 的规划和实施阶段。在已完成的 1.0 项目中，东风装备实现了经营管理的数字化。东风汽车有限公司装备公司 IS 规划首席师方明强表示，"数字装备 1.0"项目呈现出三个主要特点：一是多系统集成，目标是构建纵向到底，横向到边的系统平台，既要实现 ERP、MES 等上层系统与底层数据采集和工业网络之间的上下打通，又要实现 PDM、CAPP、ERP、MES、PMS、OA、BI、CRM 以及风控和银行支付等不同系统之间的左右贯通；二是实现包括二厂二公司 + 机关，并延伸到关联合资公司，以及二大类产品(汽车零件 + 装备产品)，十二类产品业务等在内的信息系统全覆盖；三是自主规划建设工业网络及现场工业数据采集。

在方明强看来，东风装备的数字化转型规划有一个典型的特点，就是"数字装备 1.0"目标是通过信息化集成平台建设实现经营管理的数字化，是一个面的规划和实施，而 2.0 目标是实现工业现场的数字化，是一个点到事件的管理系统，而不是一条线或者一个面的实施方式。"数字化转型分先后两个方面，先是经营管理的数字化转型，然后才是工业现场的数字化转型。如果不建立信息化平台，到生产现场就不能有效形成管理可视化和问题显性化。"方明强进一步解释道。从另一个角度来讲，这种从面到点的实施方式，是与从标准化、自动化，再到数字化、智能化的转型演进路

径相契合的，这也是东风装备及方明强一直所遵循的。"新系统上线的时候，我们是不允许工作人员进行自动配置的，必须要经过人为的操作过程。其目的就是要在工作人员心中根植标准化的思想。因为标准化是实现数字化乃至智能化的前提，这一路径不能发生错位。"方明强如此强调。

从技术使能到外部赋能 没有应用何谈推广

进入"数字装备 2.0"的实施阶段，东风装备正在逐步解决工业现场的诸多痛点问题。这个过程就是通过实现人、机、料、法、环、测等生产要素的标准化及数字化的呈现，形成管理的可视化和问题的显性化。事实上，诸多设备和工具，都是为了解决工业环境当中特定的单点问题由东风装备自主研发设计的。

也就是说，东风装备在数字装备项目的推进过程中，不仅会采用 ERP、MES、EAM 等市场上先进的 IT 系统，还会基于自身的工业生产环境和痛点需求，自主研发生产质量管控系统、在线综合测量仪、电子塞规和卡规等自动化的设备和系统。因此，在不断进行内部技术使能的基础上，东风装备具备了外部赋能的关键能力。在方明强看来，行业的发展，一定先是技术使能，然后才能进行外部赋能，二者之间不能替换，也不能颠倒。

在这一过程中，方明强也给出了数字化转型和智能制造的建议。对此，他着重提到了"整体规划，统筹设计，试点先行，分布实施"。在具体实施过程中，一定要在规划上做加法，就是要感知更多的企业难点痛点、业务场景及业务管理的应用。而实施上要做减法，首先实现全业务流程的打通，然后才能追求业务财务的一体化。

俗话说："没有金刚钻别揽瓷器活。"反过来讲，东风装备具备了这样一种外部赋能的能力，自然要把这个瓷器活揽起来。"我们在 2020 年 6 月 30 日成立了独立经营的数字智能科技作业部，目的就是要将我们在'数字装备'建设过程中所积累的先进实践经验和技术研发能力逐步的向行业内推广。而推广路径一方面是通过与解决方案提供商的合作，从事面向企业级的平台化推广，另一方面是以项目的方式，通过项目合作解决用户的一些功能及业务诉求。"方明强介绍道。

DongFeng Equipment: from Technology−Enabled to Value−Empowered Development

In a field visit held by Equipment Company of DongFeng Motor (hereinafter referred to as DongFeng Equipment), the immediate impression left is fragmented, as one sees one different dot after another, from SaaS−based quality control system, online integrated measuring instrument with multiple functional configurations, portable electronic plug gauge and card gauge capable of real−time data transmission, to operation control and data display from mobile and APP end, demonstration operation based on ERP & MES, product tracing, etc.

Digital transformation must be achieved from business management to industrial site

Now the planning and implementation of Dongfeng Equipment's "Digital Equipment" project has entered the 2.0 era. In the already completed 1.0 project, Dongfeng Equipment has realized the digitization of operation management. Fang Mingqiang, Chief IS Planner of Dongfeng Equipment, said, "Digital equipment 1.0" project has three main features. First, multi−system integration. Our goal is to build a system platform that is as much vertical and horizontal as possible. Vertically, ERP, MES and other upper systems and the underlying data collection and industrial networks need to be connected. Horizontally, different systems such as PDM, CAPP, ERP, MES, PMS, OA, BI, CRM, as well as wind control and bank payments can be integrated. Second, full coverage of information systems in Dongfeng's plant, company, offices, and related joint ventures, targeting two major products (auto parts + equipment products) and twelve types of product

Now the planning and implementation of Dongfeng Equipment's "Digital Equipment" project has entered the 2.0 era.

business. Third, independent planning and construction of industrial networks and on-site industrial data collection.

In Fang Mingqiang's view, the digital transformation planning of Dongfeng Equipment has a typical feature, that is, "digital equipment 1.0" aims to achieve digital management by building an integrated information platform. The planning and implementation is done in a broader context. However, the 2.0 project aims to achieve the digitization of the industrial site. It is building an event management system, rather than a single-dimension solution. "Digital transformation is divided into two sequential aspects, first is the digital transformation of management, and then the digital transformation of the industrial site. If we don't establish an information platform first, we can't promote visualization of management and problems at the production site." Fang Mingqiang further explained. From another perspective, this approach is in line with the transformation path that starts from standardization and automation to digitalization and intelligentization, which is also what Dongfeng Equipment and Fang Mingqiang have been following. "When the new system was launched, we did not allow the staff to make automatic configuration, as it has to go through a human operation process. The purpose is to ingrain the idea of standardization in the minds of the staff. Standardization is a prerequisite for digitalization and even intelligentization." Fang Mingqiang so emphasized.

Entering the implementation stage of "Digital Equipment 2.0", Dongfeng Equipment is gradually solving many painful problems in industrial sites.

From technology-enabled development to external empowerment; application comes first before promotion

Entering the implementation stage of "Digital Equipment 2.0", Dongfeng Equipment is gradually solving many painful problems in industrial sites. In this process, through the standardization and digital presentation of people, machines, materials, method, environment, measurement and other production elements, the visualization of management and problems can be achieved. In fact, many equipment and tools are independently designed by Dongfeng Equipment to solve

specific single-point problems in the industrial environment

In other words, in the process of digital equipment projects, Dongfeng Equipment not only uses ERP, MES, EAM and other advanced IT systems on the market, but also develops and produces quality control systems, online integrated measuring instrument, electronic plug gauge and card gauge and other automated equipment and systems based on its own industrial production environment and pain points. Therefore, continuous improvement in internal technology gave the company the key ability of external empowerment. In Fang Mingqiang's view, the development of the industry must be first enabled by technologies and then achieve external empowerment. The two can neither be replaced with each other nor reversed.

Fang Mingqiang also gave advice on digital transformation and smart manufacturing. In this regard, he highlighted the principle of "overall planning, integrated design, pilot first, and distributed implementation". In terms of the implementation process, we must do more in planning, that is, find out more difficult pain points, business scenarios and business management applications. In terms of implementation, only after the whole business process is connected can we pursue the integration of business and finance.

As the saying goes, "Don't bite off more than one can chew." Now that Dongfeng Equipment has such an ability of external empowerment, it's fair to say that it is biting off the right amount. "On June 30 this year, we established the independent Department of Digital Intelligence Technology Operations. Our aim is to promote the industry experience and R&D capabilities we accumulated in the construction of 'digital equipment'. On one hand, we cooperated with solution providers in the promotion of the platform for enterprises. On the other hand, we tried to meet some of the user's functional and business demands through projects," Fang Mingqiang said.

济源钢铁：20年数智化变迁发展史

河南济源钢铁（集团）有限公司（简称"济源钢铁"）始建于 1958 年，曾经是一家地方国有企业。2001 年，企业产权改制为全员参股的民营企业，并主导产品结构由生产普通建筑用钢转型为以生产汽车用钢、工程机械用钢等中、高端为主的优特钢。

从 2001 年携手用友 U8，实施单组织财务管理开始，二十年来，济源钢铁经历了业财一体化、集团管控、数智化转型几个重要阶段。执手二十载，恰逢弱冠之年，正是焕发生机，勇往无前之时。当下，济源钢铁正是以"创新驱动发展、管理深化变革"为活力之本，以数智化 3.0 建设为动力之源，以用友 BIP 平台为腾飞之翼，书写了一部传统钢铁企业的商业创新变迁史。

2019 年，钢铁行业在经历三年"化解过剩产能"后，供给侧结构性改革带来的政策红利逐渐衰减，高供给压力开始显现。伴随着钢铁行业运行环境复杂多变，盈利水平显著下降等不利因素，济源钢铁迎来了第二次重大的变革。

从信息化到数字化，"全连接"是企业转型的基础，也是构建数字经济新范式的信息通道。济源钢铁以企业全要素、全产业链、全价值链的全面连接，构建全新的生产制造和服务体系，改造提升旧动能，培育壮大新动能。

结合冶金行业五级架构模式，企业规划了数智化设计蓝图。以国家钢铁行业"五大发展理念"——创新、协调、绿色、开放、共享，以自身发展战略，即"在满足客户需求的前提下，将企业打造成为全面钢铁材料解决方案提供商，且成为中国一流、全球领先的优特钢精品基地"为出发点，构建了一套完整的数智化管理平台，覆盖从集团化管控到产业链延伸，从系统化集成到智能化分析的总体应用框架，并着重打造智能工厂的建设。

为了完成规划目标，济源钢铁再度携手用友，通过升级改造 ERP 系

统，增设 MDM 主数据管理平台和 ESB 接口集成平台，搭建企业"数据高速公路"。他们联手打破了企业内各业务、多组织之间的信息壁垒，实现所有系统数据的互联互通，并统一接口协议标准，让数据在企业内高速流动和共享。为此，双方项目团队共整理出 17 个主数据档案，与 YonBIP 平台对接了 20 个基础数据档案，完成 9 个集团共享数据系统。MDM 上线后，济源钢铁实现业务全流程打通，数据统一管理，实时处理，全局共享，并成为全省第一家实电商下单、客户打款、银企直连传递、MES 销产转换、厂内智能物流发货、财务核算无缝衔接的企业。

数字化叠加智能化，让济源钢铁的创新发展迎来了新的历史节点。当前，企业数智化建设从传统的流程驱动转变为数据驱动，从关注应用的构建转变为数据价值的实现，为企业的经营决策、战略制定提供依据。

数智化企业，最直观的特征是"在线化"，不仅是组织在线，业务在线，更是管理在线，创新在线。结合国家对钢铁企业安全与环保的要求，济源钢铁构建了一个 IoT 平台和两大应用，为企业的稳健发展保驾护航。

济源钢铁智能管控中心，基于 AIoT 实现统一数据采集，让生产经营可视化，实时全方位管控采购、销售、生产、能源、安环等全局。而安防应用，可以对全厂 PLC、DCS、能源仪表、微型空气站、火灾烟感报警信号、废气废水等在线监测，助力济源钢铁公司从事后控制转为向事前预警，实现安全生产，环境美丽。

在济源钢铁的数字化转型过程中，精智工业大脑发挥了重要作用。众所周知，工业大数据是工业企业实现数字化、智能化发展的关键生产要素。而精智工业大脑作为新一代 AI 生产力平台，基于用友服务 92 万家工业企业的积累，以及在工艺机理模型和算法方面的优势，帮助工业企业充分挖掘数据价值，通过数据驱动来让生产更简单，让质量更稳定，让成本更低廉，让决策更科学。

传统废钢检验定级过程中，人为因素影响大，手续较为繁琐，济源钢铁联合用友打造的智能管控中心"5G+ 废钢判定"，即是依托精智工业大脑的深度学习算法，实现对废钢的智能判定，废钢识别准确率超 90%，可大幅提升经济效益。

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Jiyuan Iron&Steel Group: Evolvement of Digitalization and Intelligentization over the Past Two Decades

Henan Jiyuan Iron and Steel (Group) Co., Ltd. (hereinafter referred to as Jiyuan Iron&Steel) was founded in 1958 as a local state−owned enterprise. In 2001, the property rights of the enterprise were reformed into the private enter− prise with full participation, and the main product structure was transformed from general construction steel to automotive steel, engineering machinery steel and other medium and high−end special steel.

In the past 20 years, Jiyuan Iron & Steel has gone through several important stages of business and finance integration, group control as well as digitalization and intelligentization since its cooperation with Yonyou U8 on single organization fi− nancial management in 2001. In its twentieth year, it is just the time to rejuvenate and move forward. At present, Jiyuan Iron & Steel is writing a history of business innovation and transformation of traditional iron and steel enterprises with "in− novation−driven development and reform−based management" as the belief of vitality, the construction of Digitalization and Intelligentization 3.0 as the source of power, and the Yonyou BIP platform as the flying wings.

In 2019, after three years of "eliminating excess capacity" in the steel in− dustry, the policy dividend from supply−side structural reform is gradually decay− ing and high supply pressure is beginning to emerge. Along with the complex and unstable operating environment of the steel industry and the significant decline in profitability and other unfavorable factors, Jiyuan Iron & Steel ushered in the sec− ond wave of reform.

From informationization to digitalization, "full connectivity" is the basis of

In the past 20 years, Jiyuan Iron & Steel has gone through several important stages of business and finance integration.

enterprise transformation, and is also the information channel to build a new paradigm of digital economy. Jiyuan Iron & Steel has built a new manufacturing and service system by fully connecting all elements of the enterprise, the whole industrial chains and the whole value chain, transforming and upgrading old kinetic energy and cultivating new ones.

Combined with the five-level structure model of metallurgical industry, the enterprise has planned a blueprint of digitalization and intelligentization. With the "five development concepts" (i.e., innovation, coordination, green, openness and sharing) of national iron and steel industry and its own development strategy (that is, "On the premise of meeting customer needs, the company will become a comprehensive steel material solution provider and China's first-class and world-leading excellent special steel boutique base") as the starting points, the company has built a complete management platform of digital intelligence, covering the overall application framework from group control to industry chain extension, from system integration to intelligent analysis, and to focus on the construction of intelligent factories.

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In the past 20 years, Jiyuan Iron & Steel has gone through several important stages, such as integration of business and finance, group control and digital transformation. It is the time to rejuvenate and move forward. At present, Jiyuan Iron and Steel has written a history of business innovation and transformation of traditional iron and steel enterprises with "innovation-driven development and deepening change in management" as the basis of vitality, the construction of Digital Intelligence 3.0 as the source of power, and the Ufida BIP platform as the wing of take-off.

In 2019, after three years of "eliminating excess capacity" in the steel industry, the policy dividend from supply-side structural reform is gradually decaying and high supply pressure is beginning to emerge. Along with the complex and changing operating environment of the steel industry and the significant decline in profitability and other unfavorable factors, Jiyuan Steel ushered in the second major change.

From informationization to digitalization, "full connectivity" is the basis of enterprise transformation and the information channel to build a new paradigm of digital economy. Jiyuan Iron and Steel has built a new manufacturing and service system by fully connecting all elements of the enterprise, the whole industrial chain and the whole value chain, transforming and upgrading old kinetic energy and cultivating new ones.

Combined with the five-level structure model of metallurgical industry, the enterprise has planned a blueprint of digital intelligence design. With the national steel industry's "five development concepts" – innovation, coordination, green, openness and sharing – and its own development strategy, i.e. "on the premise of satisfying customers' needs, the company will become a comprehensive steel material The starting point is to build a complete digital intelligence management platform, covering the overall application framework from group control to industry chain extension, from system integration to intelligent analysis, and to focus on the construction of intelligent factories.

In order to accomplish the planning goal, Jiyuan Steel once again joined hands with Yonyou to build the enterprise-level "data highway" by upgrading the ERP system, adding MDM master data management platform and ESB interface integration platform. They worked together to break through the information barriers between various businesses and organizations in the enterprise, realize the interconnection and interoperability of data from all systems, and unify the interface protocol standards so that data can flow and be shared at a high speed within enterprises.

After MDM was launched, Jiyuan realized the whole process of business interconnection, unified data management, real—time processing and global sharing, and became the first company in the province to realize the following: order placement by e—commerce, customer payment, direct bank—enterprise transmission, MES sales and production conversion, in—plant intelligent logistics shipment, financial accounting, and data sharing. It has become the first enterprise in the province to seamlessly integrate e—commerce order, customer payment, direct bank—enterprise connection, MES sales and production conversion, intelligent in—plant logistics delivery and financial accounting.

To this end, the teams from both sides have compiled 17 master data files, docked 20 basic data files with the YonBIP platform, and completed 9 group shared data systems. After the launch of MDM, Jiyuan Iron and Steel has opened up all of its business processes, unified data management, and achieved real—time processing and global sharing. Moreover, it has become the first company in Henan province to realize the seamless integration of e—commerce order, customer payment, direct bank—enterprise transmission, MES sales and production conversion, in—plant intelligent logistics delivery and accounting.

The integration of digitalization and intelligence has brought Jiyuan to a new historical point of innovation and development. At present, the construction of enterprise digital intelligence has turned from the traditional process—driven model focusing on the construction of applications to a data—driven model pursuing the realization of data value, which provides the basis for business decisions and strategy formulation.

The integration of digitalization and intelligence has brought Jiyuan to a new historical point of innovation and development.

The most salient feature of digital intelligent enterprise is "excellent", which means excellent organization, business management and innovation. Combined with the national requirements for safety and environmental protection in steel enterprises, Jiyuan Iron & Steel has built an IoT platform and two applications to ensure the sound development of the enterprise.

Jiyuan Steel's Intelligent Control Center, based on AIoT, enables unified

data collection, visualization of production and operation, and real−time all−round control of procurement, sales, production, energy, safety and environment. The se− curity application, which can monitor the whole plant PLC, DCS, energy meters, micro air station, fire smoke alarm signal, waste gas and waste water online, helps Jiyuan Iron and Steel to shift from post−control to pre−warning, thus ensuring safe production and beautiful environment.

In the process of digital transformation of Jiyuan Iron and Steel, Jingzhi Indus− trial Brain played an important role. As we all know, industrial big data is a key production factor for industrial enterprises to realize digital and intelligent develop− ment. As a new generation AI productivity platform, Jingzhi Industrial Brain, built on Yonyou's successful experience of serving 920,000 industrial enterprises and its advantages in process mechanism models and algorithms, helps industrial enterprises fully tap the value of data. Its data−driven approach has made production simpler, quality more stable, cost lower and decision−making more scientific.

Traditional scrap inspection and grading are susceptible to human factors and tedious procedures. The 5G+ scrap determination embodied in the intelligent con− trol center built by Jiyuan Iron & Steel and Yonyou is based on the deep learning algorithm of the Jingzhi industrial brain to achieve intelligent determination of scrap. With an accuracy rate of over 90% for scrap identification, it can significantly improve economic efficiency.

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杰克集团:打造企业级工业物联网应用标杆

作为全球缝纫机行业产销规模最大的企业，也是全球缝制行业中唯一一家集缝前、缝中及缝后为一体的服装智能制造成套解决方案服务商，杰克已经聚焦缝制设备产业 25 年，专注于智能吊挂、智能裁剪设备、智能缝纫机、电机及控制系统的制造研发。自然也凭借着超前的意识和眼光提前布局，开始通过工业互联网赋能智能缝纫的建设进程。

融合工业互联网与 5G 的智能制造平台

一直以来，服装行业的产业链庞杂，从纺织印染、服饰设计、裁剪缝制、熨烫打包、发货零售，每一个环节都必不可少，这就导致服装行业订单交付周期过长。

夏季做冬装、冬季做夏装，是服装行业长期执行的生产节奏。"隔季生产"模式是大订单时代的产物。而现如今，个性化、快时尚需求的持续旺盛，让"大订单时代"成为历史。加之短视频病毒式的快速传播，明星、网红超强的带货能力，服装市场的机会稍纵即逝，倒逼着服装制造形成了"高弹性、快反应"的新生产模式。在此大背景下，杰克顺势而为，以工业物联网平台为依托，向缝制设备智能制造成套解决方案服务商转型升级。

杰克与全国双跨平台之一、普适中国制造需求的工业互联网赋能平台——树根互联以及中国移动台州分公司联合打造的"5G+边缘计算 + 移动云"的工业互联网平台，基于工业互联网技术，提升缝制产业整体的数字化、网络化、智能化水平，同时还将对产业链、供应链、服务链带来数字化的升级换代，不断孵化 5G 新型生态圈。

该平台是基于 ROOTCLOUD 跨行业跨领域工业互联网平台，为杰克缝纫机建设面向缝纫机领域的"云端管理平台"，主要实施内容包括：提供基于工业互联网平台的工业设备上云解决方案，开展设备状态监测、工况优化、故障诊断、远程智能化运维服务、终端管理用户的生产过程可视化管理。

杰克工业互联网平台由物联网缝纫机（设备层）、芯片与通用网络（连接层）、云平台（平台层）、应用软件（应用层）组成。杰克提供物联网设备，树根互联提供数据平台支撑，实现产品和设备的智能通信，为服装企业信息系统数据采集和处理提供保障。

目前，杰克工业互联网平台提供——设备运行数据实时上传、任务指令下发、设备效率分析、数据报表呈现、设备参数远程设置、故障状态及时提醒等应用，能够实现工艺流程可视化、柔性化，提升多品种批量化生产的效率，减少人员，提高数据采集效率，实现制造过程可追溯性。在实际缝纫设备的制造过程中，无论是机床加工还是流水线组装，实时的生产过程会通过 5G 网络实时回传至边缘节点，再利用部署在边缘云的图像 AI 技术进行处理，从而判断产品质量是否合格，并将结果下发至产品线进行标注，从而减少对质检人员的需求。

日渐显著的转型成果

主动服务，降低备件库存和维修成本 40%，通过设备定位，设备运转状况实时监测，设备数据健康分析，杰克可对售出设备进行有效监控，对于市场布局、备品配件投放做到有数据支撑，及时预测故障及备件换算率，节约了大概 50% 的备件在库数量，节约了 40% 的维修费用。

提高设备应用效率，降低停机时间 60%，提升后市场服务价值，通过对缝纫机使用状态的实时监控及故障预测，厂商能够及时给终端用户提供主动服务，因产品原因导致的停机时间可降低 60% 以上，挖掘提升更多的后市场服务价值。

远程 OTA 升级，提升服务效率 10%，后台通过大数据分析用户使用习惯，以及缝纫机在不同场景下的参数变化，在研发端进行有效的技术改进，可将程序直接通过 OTA 进行远程升级或者指令下发，实现了缝纫机的远程运维服务以及动态调整功能，有效防止人员过度损坏所带来的寿命损伤，帮助缝纫机提升 10% 的使用寿命。

Jac k Group: Moving towards a Bench-mark for Enterprise-Level Industrial IoT Applications

As the largest enterprise in the global sewing machine industry in terms of production and sales, and the only one provider in the global sewing industry that integrates pre-sewing, sewing and post-sewing as a complete set of solutions for garment intelligent manufacturing, Jack has been focusing on the sewing equipment industry for 25 years. Its main businesses include the manufacturing and R&D of intelligent hanging, intelligent cutting equipment, intelligent sewing machines, motors and control systems. Naturally, it has also started the construction process of intelligent sewing through industrial internet empowerment with its business acumen and vision.

Smart manufacturing platform integrating with Industrial Internet and 5G

The industry chain of garment industry has always been complicated. From textile printing and dyeing, apparel design, cutting and sewing, ironing and packing, to shipping and retailing, each link is essential, which leads to a long order delivery cycle in the garment industry. The long-standing production practice of the garment industry is to make winter clothes in summer and summer clothes in winter.

The "alternate season production" model is a product of the era of large orders. Nowadays, personalized, fast fashion demand continues to flourish, which renders the "big order era" a history. Plus, the rapid spread of short videos and the promotion effect of celebrities have made the apparel market opportunities

From textile printing and dyeing, apparel design, cutting and sewing, ironing and packing, to shipping and retailing, each link is essential, which leads to a long order delivery cycle in the garment industry.

increasingly precious, thus giving birth to the new production model of "high elasticity, fast response" of the clothing manufacturing industry. Against this backdrop, Jack followed the trend and upgraded to a solution provider for intelligent manufacturing of sewing equipment based on the Industrial Internet of Things platform.

Jack, Root Cloud, one of the national "double−cross" (cross−industry and cross−field) platforms and the industrial Internet empowerment platform that is universally applicable to China's manufacturing needs, as well as China Mobile Taizhou Branch jointly build the industrial Internet platform of "5G + edge computing + mobile cloud".

Based on industrial Internet technology, the platform will enhance the overall digitalization, networking and intelligence of the sewing industry, promote digital upgrade in the industrial chain, supply chain and service chain, and help incubating a new 5G ecosystem.

Based on the Root Cloud cross−industry and cross−field industrial Internet platform, the platform aims to build a "cloud management platform" for Jack's sewing machines in the industry. The main scope pf implementation includes providing cloud solutions for industrial equipment based on the industrial Internet platform, equipment status monitoring, work condition optimization, fault diagnosis, remote intelligent operation and maintenance services, and visualization management of the production process for terminal management users.

Jack's industrial Internet platform consists of IoT sewing machine (device layer), chip and common network (connection layer), cloud platform (platform layer), and application software (application layer). Jack provides IoT devices and Root Cloud provides data platform support to realize intelligent communication of products and devices and provide data collection and processing for information system of garment enterprises.

At present, Jack's industrial Internet platform provides functions including real−time uploading of equipment operation data, task instruction issuance,

Based on the Root Cloud cross−industry and cross−field industrial Internet platform, the platform aims to build a "cloud management platform" for Jack's sewing machines in the industry.

equipment efficiency analysis, data report presentation, remote setting of equipment parameters, timely reminding of fault status, etc.

At the same time, process visualization and flexibility are achieved to enhance the efficiency of multi-species batch production, reduce personnel, improve data collection efficiency, and improve the traceability of manufacturing process. In the manufacturing process of actual sewing equipment, whether it is machine tool processing or assembly line, the production process will be transmitted back to the edge node in real time through the 5G network, and then processed using the image AI technology deployed in the edge cloud, so as to determine whether the product quality is qualified. Then, the results will be sent down to the product line for labeling, thus reducing the need for quality inspection personnel.

Increasingly significant transformation results

Active service to reduce spare parts inventory and maintenance cost by 40%. Through equipment positioning, real-time monitoring of equipment operation condition and equipment data health analysis, Jack can effectively monitor the sold equipment, and have data support for market layout and spare parts placement. In addition, timely prediction of failure and spare parts conversion rate helped saving about 50% of spare parts in storage and 40% of the maintenance cost.

Improve equipment application efficiency, reduce downtime by 60% , and enhance after-market service value. Through real-time monitoring of sewing machine usage status and fault prediction, manufacturers can provide active service to end users in a timely manner, and downtime due to product reasons can be reduced by more than 60%, thus tapping more after-market service value.

Remote OTA upgrade to improve service efficiency by 10% . In the backstage, the user's usage habits and the changes of sewing machine parameters in different scenarios are analyzed through big data. The R&D Department makes technical improvements, by which the upgrade program can be directly completed remotely through OTA and the instructions can be issued, realizing the remote

operation and maintenance service and dynamic adjustment function of the sewing machine, effectively preventing the life damage caused by excessive damage of personnel. Besides, it has also helped increasing the service life of sewing machines by 10%.

新奥集团:
从RPA到AI自动化平台智能化演进加速

2019 年,代号"RPA"的 IBM 流程自动化机器人化身虚拟员工"小奥助理"入职了新奥集团财务共享中心。短时间内,"小奥"就进入了角色,平均每天可以完成 2000~3000 个任务,相比人工平均可缩短 60% 的工作时间,连接支撑了超过 70 个的业务场景,产生了数百万元的业务价值。

在新奥集团数字技术赋能群人工智能中台负责人李强看来,"RPA"的应用,实现了某个流程节点上的觉醒,节省了以往重复性、复杂性工作所带来的繁重任务量。以财务共享中心的应用为例,以前发票单独校验这一单个节点的工作就需要 11 个人来完成,现在仅仅需要 1.5 个人,而节省下来的人工可以完成更多其他业务。

然而,对于一家跨多行业,拥有数百家下属公司的集团企业来讲,仅仅实现诸多单个节点的自动化,似乎并不能应对复杂场景下的业务需求。"新奥集团在多领域、多场景的广泛覆盖以及来自集团内部数百个业务系统每天数十 T 数据量的管理需求,在使其成为 AI 场景优质孵化场所的同时,也要求新奥集团在应用 IBM RPA 的基础之上,通过融入更多、更强大的人工智能技术,构建契合自身业务发展的 AI 自动化平台,从而实现从单个节点的自动化到整体业务流程自动化的转变,为打造'数字员工',重塑数字化工作场所奠定基础。"李强如此说道。

以多维技术能力 支撑 AI 场景落地生花

为了最大限度地规避风险,新奥集团秉持三个重要原则开始产品的考量和选型。"一是易用,就是在没有专家辅助的情况下,没有任何编程能力的人也能够直接训练对话机器人;二是快速,业务的快速迭代必然要求系统的及时响应,所以需要以零编码的形式快速实现场景搭建,省去开发测试的时间;三是开放,由于集团内部存在诸多业务系统,所以要求机器

在新奥集团数字技术赋能群人工智能中台负责人李强看来,"RPA"的应用,实现了某个流程节点上的觉醒,节省了以往重复性、复杂性工作所带来的繁重任务量。

人对话流程的任意节点都可以插入任意第三方的集成接口。"李强这样总结道。

经过半年时间，在把市场上几乎所有能看到的产品都试用过之后，IBM Watson 进入了新奥集团的视野。在李强的预想当中，在新奥集团内部，希望把 Watson 作为一个快速的人机交互窗口，利用其自然语言的处理能力，使得员工几乎不需要学习成本，只需要通过人类自然语言就可以向机器表达意图，从而访问企业内部业务中台上的各种微服务，并且基于 RPA 去发起各种自动化的业务流程。

不曾想，这种对于快速交付 AI 业务场景的设想，在疫情复工的实际应用当中变成了现实。李强提到，复工之初，大量员工要求实施远程办公环境配置。人工客服电话在当天就暴增了 3 倍，还有大量的员工在线等待。基于这种需求，新奥的自动化团队只用了一个晚上的时间，通过将 Watson 和现在已经有的各种 RPA 的自动化流程进行对接，让所有员工在不需要任何培训的情况下，就可以 7×24 小时通过移动端和 Watson 直接对话，并发起后台的各种操作。

以多元适配能力 满足复杂应用需求

李强提到："新奥集团基于 IBM Watson 主要打造了三类应用场景：第一类是员工自助服务。作为集团企业，员工之间的协同很困难。我们不仅要把包括财务、人力、OA 和 IT 在内的职能部门的服务能力抽象出来，封装在 AI 自动化平台上，还需要把长链条低效的服务打开，不再为了解决单个问题，去找特定人员解决。在自动化平台上，把它变成了点对点的服务，80%的问题就由 24 小时在线的机器人来解决，20%机器人处理不了的，直接转在线的人工服务。第二类是虚拟员工助理。我们通过 AI 直接对员工日常工作进行赋能，目标是要实现增强型的混合劳动力，给他提供私有的 AI 技能，帮他执行日常任务，把他从日常工作中解放出来，释放他的创造力和想象力。第三类是专家助手。我们规划使用 Watson Discovery 对类似于像大量的合同，各种产品的帮助文档，还有企业的各种报告等非结构化的文本进行处理。不是以文件为单位，而是以自然语言的段落、语句为单位，

案例篇 》
Cases

去自动梳理知识点，再去支撑机器人，帮助员工回答一些海量的无法通过对话训练直接回答的问题。"与此同时，新奥集团正在实施的 AI 自动化平台，目前正以每年上百个应用场景的速度快速发展，希望在两年之内能够形成覆盖整个集团的 AI 共享能力集市。

ENN Group:
Accelerating Intelligent Evolution from RPA to AI Automation Platform

In 2019, IBM's process automation robot code named "RPA" joined the financial sharing center of ENN Group as a virtual employee, "ENN Assistant" (Xiao'Ao). In a short period of time, "Xiao'Ao" has got up to speed and could complete an average of 2,000－3,000 tasks per day. Shortening the working time by 60% on average compared to manual work, it supported more than 70 business scenarios and generating millions of business value.

In the view of Li Qiang, Head of the Artificial Intelligence Center, Digital Technology Empowerment Group of ENN, the application of "RPA" has helped saving the heavy task volume caused by repetitive and complex work in the past. Taking the application of the financial sharing center as an example, invoice verification used to require 11 people to complete, but now it only requires 1.5 people, and the saved labor can be engaged in many other businesses.

However, for a group enterprise with hundreds of subsidiaries across multiple industries, automation of this extent does not seem to be able to cope with the business needs in complex scenarios. "Covering businesses in multiple fields and scenarios, ENN has data management needs of tens of T per day from hundreds of business systems within the group, which makes it a high－quality incubator for AI scenarios. However, it also means that ENN needs to build an AI automation platform that fits its business development by incorporating more and more powerful AI technologies on top of the application of IBM RPA AI automation platform, so as to realize the transformation from the automation of single nodes to the overall business process automation, and lay the foundation for creating a

'digital workforce' and reshaping the digital workplace." Li Qiang said.

Multi−dimensional technical capabilities to support AI implementations

In order to avoid risks to the greatest extent possible, EN Group started product consideration and selection based on three important principles. "The first is Ease of Use, that is, without the assistance of experts, people without any programming skills can directly train the dialogue robot; the second is Fast. The rapid iteration of business inevitably requires timely response of systems, so it is necessary to quickly build the scene in the form of zero coding, thus saving the time of development and testing; the third is Open. With the many business systems within the group, any node of the robot dialogue process shall be able to be inserted into any third−party integration interface." Li Qiang said.

After half a year, after trying almost all the products available in the market, IBM Watson came into view. In Li Qiang's vision, Watson was to be used as a fast human−machine interaction window within ENN Group, using its natural language processing capabilities to enable employees to express their intentions to the machine through human natural language with almost no learning cost, to access various micro−services on the internal business platform, and to initiate various automated business processes based on RPA.

Unexpectedly, this vision for rapid delivery of AI business scenarios became a reality in the practical application of post−epidemic work resumption. Li mentioned that at the beginning of work resumption, the large number of employees requested the implementation of remote office environment configuration. The number of manual customer service calls tripled on the same day, and still a large number of employees were waiting online. Based on this demand, ENN's automation team spent only one night, by interfacing Watson with the various RPA automation processes that are already in place now, allowing all employees to talk directly with Watson and initiate various operations in the

backstage via mobile 24/7 without any training.

Meet complex application requirements with multiple capabilities

According to Li Qiang, "ENN has created three main application scenarios based on IBM Watson: the first one is employee self-service. In a large group, collaborations among employees are difficult. We not only need to abstract the service capabilities of functional departments including finance, human resources, OA and IT and encapsulate them in the AI automation platform, but also need to open up the long chain of inefficient services. By doing so, we hope that when our employees want to solve a single problem, they no longer have to turn to a specific person. The automation platform provides point-to-point services where 80% of the problems will be solved by online robots 7/24, while for the 20% that robots can not handle, they are directed to the online human services. The second is the virtual employee assistant. Our goal is to achieve an enhanced mixed workforce by providing him with private AI skills to help him perform his daily tasks, freeing him from his daily work and releasing his creativity and imagination. The third is expert assistants. We plan to use Watson Discovery to process unstructured text like contracts, product help documents, and various company reports. Instead of using documents as a unit, we will use natural language paragraphs and statements as a unit to automatically sort out knowledge points and then support robots to help employees answer some questions that cannot be answered directly through dialogue training."

In addition, the AI automation platform being implemented by ENN Group is currently developing rapidly at a rate of hundreds of application scenarios per year, and it is hoped that within two years an AI shared capability bazaar covering the entire group will be formed.

Entering the implementation stage of "Digital Equipment 2.0", Dongfeng Equipment is gradually solving many painful problems in industrial sites.

英飞凌：
提高设备数字化程度 实现高效生产

研究表明，截至 2020 年，全球约有 270 亿台物联网设备，这一数字到 2025 年将猛增至 750 亿。这一过程会带来新的经济增长机遇，机器、系统的彼此互联有助于提升效率，实现流程同步。据德国工业联合会（BDI）预测，若工业朝着正确的数字化转型方向发展，则到 2025 年，德国将有可能创造 4250 亿欧元的增值，而整个欧洲将能创造高达 1.25 万亿欧元的增值，这一数字对中国而言只会更高。

作为德国工业 4.0 的初创成员和德国工业 4.0 工作小组的核心成员，英飞凌深刻意识到，随着工业互联网、物联网及工业 4.0 的发展，制造业工厂对设备自动化、数字化的需求越来越高。设备自动化系统需要使能设备上传下载处理程式、数据自动采集、设备事件和警报的收集等，以便与车间作业层系统：如生产执行 MES、配方管理 RMS、数理统计质量控制 SPC、失效检测和分类 FDC、先进流程（工艺）控制 APC 等系统实现实时信息交互，通过集成实现效能提升。同时，先进流程（工艺）控制 APC 更已成为提高产品质量、稳定工艺的重要工具，也是智能工厂建设的一个关键点。提高自动化和数字化程度，特别是 APC 的应用，实现工厂的高效生产，是达到卓越运营的重要手段。

然而，这一愿景往往受制于现有设备数字化能力不足的现实问题。多年前，工厂在布局时，往往会对设备自动化提出要求，而对设备的联网和数字化由于应用场景不丰富或投入预算的限制而没有做到超前满足。但随着工业互联网、物联网、智能制造大数据场景的丰富，只有设备提供相关的数据，公司才可对数据进行分析利用，从而进一步产生价值。

此外，对旧设备还存在不同的设备类型和厂商的能力和成本问题。第一，工厂的设备根据工艺不同分为诸多种类，半导体后道封装行业涵盖了划片到测试一系列设备，结合工艺要求和设备品牌来看，最少也有几十种，

采集对象涵盖报警信息、实时参数信息、设备状态事件。设备通过与 ECA 互联，将采集的信息通过 SECS/GEM 发送给系统。系统可利用此类信息进行高级工艺控制 APC 和其他智能分析及管控。

其联网能力各不相同。第二，工厂投资的设备跨度有几年甚至十几年，每一代的设备联网能力也不同，老一代的设备只有有限联网能力，日渐难以满足发展要求，而要厂商升级设备是一笔很大的投入。第三，设备原始制造商的能力差异也造成了设备联网能力的不同，往往大型制造商的设备有较好的联网能力。第四，对半导体行业特有的通讯协议支持对设备制造商也是一个较高的门槛，设备联网功能的开发通常时间周期比较长。

由于种种限制以及公司内部对于各个半导体设备信息采集的日益高涨的期望，设备的数字化能力形成了智能制造的瓶颈。但在短时间内升级设备能力周期长，成本也很难控制，同时往往缺乏一致性，所以各个厂商会使用其偏好的数据互联方案，这样便增加了系统复杂度，也增加了使用和维护难度。

为解决上述痛点问题，英飞凌决定开发出针对设备层的包含软件和硬件的解决方案，以满足日益增长的设备信息互联需求，并且能够即插即用，标准化协议和数据格式，灵活适应公司内部现有信息平台，避免针对不同种类设备、不同代设备开发不同的数据采集方案，降低系统复杂程度，达到公司内部设备标准化互联。

英飞凌决定在深入分析自身对设备自动化系统需求的前题下，开发一款高级设备互联产品 ECA，重点实现三大功能：一是开发 ECA 软件以及找到运行产品的硬件作为设备层互联工具；二是 ECA 可以根据设备自动化系统的需求灵活的配置软件和硬件，做到模块化；三是转化采集信息为符合半导体行业标准协议（SEMI E4、E5、E30、E37 的 SECS/GEM）的通信方案。重点相关技术为：PLC 技术、软件开发、设备通信技术、传感器技术、SECS/GEM 通信协议。

根据对工厂内部设备的调查和主要分类，基于数据类型主要有，设备报警信息、设备实时参数反馈、设备状态事件。基于现有设备通信端口的主要分类有：RJ45 网络端口、RS232/485 串行端口、设备传感器 I/O 接口。

基于当前设备的情况和要求，产品的目标即基于上述条件开发出基于网络端口、串行端口，以及传感器 I/O 信息采集的高级设备互联产品 ECA，产品需满足模块化要求，可根据应用选择配置，合理兼容公司内部现有的

设备自动化平台。采集对象涵盖报警信息、实时参数信息、设备状态事件。设备通过与 ECA 互联，将采集的信息通过 SECS/GEM 发送给系统。系统可利用此类信息进行高级工艺控制 APC 和其他智能分析及管控。

Infineon: Promote the Digitalization of Equipment and Achieve Efficient Production

Research shows that there are approximately 27 billion IoT devices worldwide by 2020, the number of which will soar to 75 billion by 2025. This process will open up new opportunities for economic growth, when the interconnection of machines and systems to each other will assist to promote efficiency and synchronize processes. According to the German Industry Federation (BDI), if industry moves in the right direction towards digital transformation, Germany will potentially generate □425 billion in value added by 2025, the number of which will hit □1.25 trillion in the whole Europe, a figure that will only be higher in China.

As a founding member of German Industry 4.0 and a core member of the German Industry 4.0 Working Group, Infineon is acutely aware of an increasing demand for equipment automation and digitalization required in manufacturing plants with the development of the Industrial Internet, the IoT and Industry 4.0. Equipment automation systems shall enable equipment to upload and download processing programs, collect data automatically, and gather equipment events and alarms, etc., thus to realize real-time information interaction with shop floor operational systems: such as manufacturing execution system (MES), recipe management system (RMS), statistical process control (SPC), failure detection and classification (FDC), advanced process (technology) control (APC), etc., and efficiency will be improved eventually through integration. At the same time, APC has become not only a crucial tool for improving product quality and stabilizing processes, but also a key point in the construction of smart factories. Improving automation and digitalization, especially making the use of APC, are significant means to realize efficient factory production and achieve operational excellence.

At the same time, APC has become not only a crucial tool for improving product quality and stabilizing processes, but also a key point in the construction of smart factories.

However, this vision is often hampered by the insufficient digitalization of existing equipment. Years ago, factories tended to lay out their requirements for equipment automation, but failed to met ahead of time the networking and digitization of equipment for the lack of rich application scenarios or for limited budget. Nevertheless, as big data scenarios of the Industrial Internet, the IoT and smart manufacturing grow rich, enterprises can only analyze and utilize the data to generate further value if the equipment provides relevant data.

In addition, the problems of different equipment types, vendor capabilities and costs still remain for older equipment. 1. Equipment in the factory is divided into multiple types according to different processes. The semiconductor back-end packaging industry covers a wide range of equipment from scribing to testing and in combination with process requirements and equipment brands, there are at least a few dozen different types of equipment with uneven networking capabilities. 2. Equipment invested by the factory spans several years or even a decade, and each generation of equipment embraces different networking capabilities. Older genera-tions of equipment with limited networking capabilities are becoming increasingly difficult to meet growing demands, and it is a significant investment for manufac-turers to upgrade the equipment. 3. Uneven capabilities of the original equipment manufacturers also contribute to differences in the networking capabilities. Often the equipment produced by large manufacturers own better networking capabili-ties. 4. Support for communication protocols specific to the semiconductor industry is also a high threshold for equipment manufacturers, and the development of e-quipment networking capabilities usually has a long lead time.

The digital capability of equipment compromises a bottleneck for smart man-ufacturing due to various limitations and the growing expectations within enter-prises for information collection by individual semiconductor devices. However, upgrading equipment capabilities requires a long lead time in the short run and the cost is hard to control, and there is often a lack of consistency, so individual manu-facturers are tend to utilize their preferred data interconnection solutions, which

The collected objects shall cover alarm information, real-time parameter information and equipment status events.

however adds to the complexity of the system and the difficulty in use and mainte−
nance.

To address aforementioned issues, Infineon decided to develop a solution for the equipment that compromises both software and hardware to meet the growing demand for interconnection of equipment information, which is capable of plug and play, can standardize protocols and data formats, and is flexibly adapt to existing information platforms within the enterprise. The solution will avoid developing different data collection plans due to varying types and generations of equipment, and it will reduce system complexity to achieve a standardized interconnection of equipment within the enterprise.

Infineon decided to develop an advanced device interconnection product, E−CA, based on an in−depth analysis of its own requirements for device automation systems. The product is expected to achieve three main functions: 1. develop ECA software and identify a hardware to run the product as a device level interconnec−tion tool; 2. ECA allows for flexible configuration of software and hardware ac−cording to the needs of the device automation system, making it a modular; 3. converse collected information into a communication solution that complies with semiconductor industry standard protocols (SECS/GEM for SEMI E4, E5, E30, E37). Key related technologies include PLC technology, software development, e−quipment communication technology, sensor technology and SECS/GEM com−munication protocols.

According to a survey of the plant equipment and the major classifications: the main types of data are equipment alarm messages, equipment real−time parameter feedback, equipment status events. The main types of existing equipment commu−nication ports are RJ45 network ports, 2, RS232/485 serial ports and equipment sensor I/O interfaces.

Considering the current equipment situation and requirements, the product objective is to develop an advanced equipment interconnection product ECA ac−cording network ports, serial ports and sensor I/O information collection based on

the aforementioned conditions. The product needs to meet the modular require－ments, and it can be configured according to application options, and it shall be reasonably compatible with existing equipment automation platforms within the enterprise. The collected objects shall cover alarm information, real－time parame－ter information and equipment status events. After interconnected to ECA, the e－quipment sends the collected information to the system via SECS/GEM. The sys－tem can make use of the information to control APC with advanced process and take other intelligent analysis and control.

菲尼克斯数字化转型之路

菲尼克斯电气集团成立于 1923 年，总部位于德国汉诺威附近的 Blomberg，在近 100 年的发展中，菲尼克斯电气始终以技术创新作为核心竞争力，逐渐发展成为了全球电气连接、电子接口与工业自动化领域的市场领袖。目前共拥有超过 60 000 种系列产品，而且每年都推出近 3 000 种新产品，是工业领域当之无愧的隐形冠军企业。

过去几年间，自动化、信息化与数字化给行业和企业都带来了巨大改变。对于市场发展变化拥有敏锐嗅觉的菲尼克斯，在 2017 年就面向下一个 100 年发展制定了计划，即抓住数字化转型的历史机遇，致力于发展成为一个数字化的工业公司。

数字化转型的必要性及实现途径

数字化转型给企业带来的影响是非常巨大的，比如以数据为核心的业务模式、数字化的产品组合、客户互动的数字化、生产的数字化、支持过程的数字化等。为此，菲尼克斯总结出了自己的一套方法论，即企业数字化转型的整体解决方案。菲尼克斯认为，企业的数字化转型需要清晰坚定的愿景和有针对性的战略。菲尼克斯的企业愿景是在所进入的领域中，保持技术和市场的全球领先地位，数字化愿景是以先进技术的独特运用，在行业内构建通往互联互通世界的发展之路。而在策略方面，菲尼克斯则制定了数字化转型程序模型。从分析到愿景再到战略，系统性地规划数字化转型的落地实施。

从愿景到项目，菲尼克斯确立了四个数字化战略的目标领域：数据为中心的业务模式、数字化产品组合、客户交互的数字化、智能化和网络化的过程。并且设置了战略项目地图和灯塔项目，用来持续判断每一个行动是否在正确的方向上。在菲尼克斯的数字化蓝图里，有清晰的各项要素图表，包括业务模式、产品组合、客户界面及过程，又具体到市场、流程、

菲尼克斯的企业愿景是在所进入的领域中，保持技术和市场的全球领先地位，数字化愿景是以先进技术的独特运用，在行业内构建通往互联互通世界的发展之路。

员工和创新这些载体上。在考虑到各要素之间的交集时，就会诞生很多新的基于市场需求和业务模式的产品和解决方案，比如菲尼克斯开发的全新一代开放式控制平台 PLCnext 以及工业云平台 Proficloud，再比如新的产品组合如数字化双胞胎 Digital Twin、新一代连接器 Connector 2023 等。

数字化转型成果——智能示范工厂

菲尼克斯电气打造的智能工厂 2.0 具备生产、物流、仓储、餐饮、住宿等功能，是一个集精益布局、智能物流、准时化配送、高度自动化、精益产线和数字化车间于一体的中国智能制造示范项目，还将全面引入 PLCnext 技术，贯穿数字化概念和新兴技术。

在智能决策与管理数字化方面，菲尼克斯运用 APS 系统、MES、WMS、监控系统、BI 系统、保修系统构成中控支撑平台。综合运用数据采集、数字化工厂、远程监控、电子看板、Dashboard 等技术，构建生产控制中心，实现对生产过程的实时跟踪、过程采集、协同处理、应急指挥、集中管控和决策与管理数字化。

管理数字化就是要清晰地知道生产运营情况，通过 MES 可以把制造系统和管理数字化链接起来，同时有很多智能的机械装备系统和也要与 MES 进行互联互通。同时还有质量检验、各种设备装、物流系统、楼宇控制系统以及 HR 系统等，作为整体数字化具有重要意义，但是实施起来却不是那么简单，因为版本不同，各系统之间兼容性问题等。

在数字化研发平台方面，菲尼克斯着力解决信息化到数字化转型的矛盾，解决信息化中信息孤岛问题，解决各平台间无法互联互通等问题。用数字化理念在各平台间建立起互联互通的关系，成为系统解决方案，如产品生命周期管理平台 Team Center、项目管理平台 EPO、研发数据管理平台 OSM 以及审批系统、各种工具软件平台等。从新品论证到项目启动、3D 结构图设计、平面设计和数据维护等业务，菲尼克斯已经研发实现了多系统互通。未来菲尼克斯电气德国总部将集中精力推行 TC 来替代 OSM 平台，后续与 MES 等软件的交互更多的定义在 TC 中。

在生产数字化方面，菲尼克斯从生产运营的目标实现角度考虑问题。

更高的质量、更高的柔性、更高的生产效率、更短的交货周期、更低的边际成本、更短的产品研发周期以及满足客户更加个性化的需求，是每个生产企业追求的目标，生产数字化应当从技术和系统的堆砌，转变成可以映射到价值流的痛点上工具集，从而解决生产实际问题。因此，菲尼克斯总结出，对于生产运营而言，生产数字化只是工具手段，不是目的。

Phoenix＇s Road to Digital Transformation

Founded in 1923 and headquartered in Blomberg near Hanover, Germany, Phoenix Contact has been a global market leader in electrical connections, elec－tronic interfaces and industrial automation for nearly 100 years, with technological innovation as its core competence. With more than 60,000 product lines and nearly 3,000 new products every year, Phoenix is a champion of the industrial sector.

Over the past few years, automation, information technology and digitalization have brought great changes to industries and companies alike. Phoenix, which has a keen sense of market development and change, has made plans in 2017 for the next 100 years of development, i.e. to seize the historical opportunity of digital transformation and commit to developing into a digital industrial company.

The need for digital transformation and the ways to achieve it

The impact of digital transformation on companies is enormous, such as a data－centric business model, a digital product portfolio, the digitization of customer interactions, the digitization of production and support processes, etc. For this reason, Phoenix has summarized its own methodology, a total solution for the digital transformation of enterprises. Phoenix believes that the digital transformation of a company requires a clear and firm vision and a targeted strategy. Phoenix＇s corporate vision is to maintain global leadership in technology and markets in the areas it enters, and its digital vision is to build a path to a connected world in the industry with the unique use of advanced technologies. As for the strategy, Phoenix has developed a digital transformation process model. From analysis to vision to strategy, the implementation of digital transformation is planned within a system.

Over the past few years, automation, information technology and digitalization have brought great changes to industries and companies alike.

From vision to projects, Phoenix established four target areas for its digital strategy: data-centric business model, digital product portfolio, digitalization of customer interactions, and intelligent and networked processes. And a strategic project map and a lighthouse project were set up to continuously judge whether each action is on the right track. In Phoenix's digital blueprint, there is a clear diagram of each element, including business model, product portfolio, customer interface and processes, and again specifically on the vectors of markets, processes, employees and innovation. When considering the intersection between the elements, many new products and solutions based on market needs and business models are born, such as the new generation of open control platform PLCnext and the industrial cloud platform Proficloud developed by Phoenix, as well as new product portfolios such as Digital Twin, the new generation of connectors Connector 2023 and many more.

Results of digital transformation – Smart Demonstration Factory

Phoenix Contact has created the Smart Factory 2.0 with production, logistics, warehousing, catering and accommodation functions, a Chinese smart manufacturing demonstration project integrating lean layout, smart logistics, just-in-time distribution, high automation, lean production lines and digital workshops, which will also fully introduce PLCnext technology throughout the digitalization concept and emerging technologies.

In terms of intelligent decision-making and management digitization, Phoenix uses APS system, MES system, WMS system, monitoring system, BI system and warranty system to form a central control support platform. Data collection, digital factory, remote monitoring, electronic signage, Dashboard and other technologies were used to build a production control center to achieve real-time tracking, process acquisition, collaborative processing, emergency command, centralized control and digitalization of production processes and decision-making and management.

Phoenix Contact has created the Smart Factory 2.0 with production, logistics, warehousing, catering and accommodation functions, a Chinese smart manufacturing demonstration project integrating lean layout.

The aim of management digitalization is to have a clear idea of how the production is operating. The manufacturing system can be connected with intelligent mechanical equipment systems and management digitalization through the MES system. Besides, though the digitalization of quality inspection, equipment installation, logistics system, building control system and HR system, etc. has huge significance, but it ia not easy in implementation due to different versions and compatibility problems between systems.

In terms of digital R&D platform, Phoenix focuses on solving the contradiction from informationization to digital transformation, solving the problem of information silos in informationization and the inability to interconnect between platforms, etc. The digital concept is used to establish interconnection and interoperability between platforms as system solutions, such as Team Center, a product lifecycle management platform, EPO, a project management platform, OSM, a R&D data management platform, and approval systems, various tool and software platforms, etc. From new product demonstration to project initiation, 3D structure drawing design, graphic design and data maintenance operations, Phoenix has achieved multi−system interoperability through R&D. In the future, Phoenix Contact Germany headquarters will focus on implementing TC to replace the OSM platform, with subsequent interactions with MES and other software defined more in TC.

In terms of production digitization, Phoenix considers the problem from the point of view of achieving the goals of production operations. Higher quality, higher flexibility, higher productivity, shorter lead times, lower marginal costs, shorter product development cycles and meeting customers' more personalized needs are the goals that every production company pursues, and production digitization should be transformed from a stack of technologies and systems to a tool set that can be mapped to the pain points of the value stream, thus solving the actual problems of production. Therefore, Phoenix concluded that for production operations, production digitalization is only a means, not an end.

海尔数字科技：
让数字化成为"疫情背景下"的发展引擎

　　海尔数字科技（青岛）有限公司（以下简称"海尔数字科技"）是海尔卡奥斯物联生态科技有限公司的全资子公司，主要从事数字科技、智能科技、软件科技、互联网技术领域内的技术开发、技术咨询、技术转让、技术服务等业务。

　　目前，海尔数字科技正在实施跨行业的生态服务，从工业互联网平台应用层提供从交互定制、研发到物流、服务等全周期零距离一体化生态服务，每个节点一方面提供标准化定制化解决方案，核心服务方案预计可提升企业整体运营效率 5%～10%，预计可以给制造业带来数千亿元的成本节约。

　　当前，COSMOPlat 平台正从家电行业向其他行业延伸。通过用户交互、研发创新、协同采购、智能制造、智慧物流、精准营销和智能服务等七大模块化解决方案，可以采取"即插即用"选择式或全流程解决方案应用来中小企业提升全流程竞争力，最终实现提质增效、资源配置和模式的转型。目前，COSMOPlat 平台已拓展了在包括机械、模具、服装、电子、建陶、能源、房车、农业、医疗和化工等 15 个行业生态。在平台上企业、各类资源和用户都可以零距离交互、创造价值、体验迭代和增值分享，赋能广大中小企业升级转型，实现攸关方价值最大化。

数字化平台 助力疫情控制推动复工复产

　　2020 年，新冠肺炎疫情爆发之初，一名卡奥斯 COSMOPlat 创客遇到购买口罩困难的问题后，发现普通医用口罩陷入全国缺货状态，普通群众和抗疫一线的医护人员很难做到基本防疫。该卡奥斯 COSMOPlat 创客迅速联手 3 位创客，整合卡奥斯 COSMOPlat 研发团队经过 2 个昼夜的论证、研发、试验，迅速上线新冠肺炎疫情医疗物资信息共享资源汇聚平台，助

力企业匹配复工所需资源，赋能防疫物资生产企业产能提升，抗疫保安全。平台可实现防治疫情物资的供需信息及时、准确零距离互联互通，来帮助疫区需求和生产企业物资更高精度更高效率的匹配，同时也为政府物资调配提供数据的支持，有力的支撑疫区物资保障。人单合一模式下的自组织、自进化，使该平台的成功上线得到了验证，展现了企业联动政府、资源上下游产业链的多元协同能力，体现了卡奥斯 COSMOPlat 平台在工业互联网时代下数字大规模定制的优势。卡奥斯 COSMOPlat 平台在疫情期间赋能了诸多相关医疗机构。

后疫情时代 数字化平台助力企业增产增效

在国内疫情缓解之时，卡奥斯 COSMOPlat 平台升级为企业复工增产服务平台，通过企业复工全要素专区、疫情医护物资供需专区、居家保障专区三大系统，满足企业、医院、学校、政府等组织机构疫情防控及复工增产需求，上线 10 天累计服务近 500 个企业、政府单位，为企业安全复工提供信息化支撑，为政府管理者减轻信息收集工作量。卡奥斯 COSMOPlat 平台重点围绕人、机、料、法、环 5 大节点，打造了 16 项场景解决方案，全要素、全流程、全产业链赋能企业，为企业输出一份抗疫保安全、复工有保障、增产有成效的"硬核指南"。

从最初企业的供需平台，到复工增产服务平台，到医用物资全产业链平台，再到现如今的应急物资新生态，卡奥斯的每一步都紧跟用户需求。平台主要通过线上数字化平台 + 线下智慧园区相协调的生态模式，搭建全流程全要素多层次持续迭代的工业互联网平台，以用户为中心实现全产业链赋能，通过聚合资源，线上线下结合，实现全产业耦合，增加生态价值、最终实现生态各攸关方的共赢。实践案例如卡奥斯 COSMOPlat 平台集成了各行业的数字供应链操作系统，隆菲依托这个公共平台，隆菲医疗得以高效精准地完成核心生产线、设备、原材料等生产资源的调配，并通过智慧化、定制化的解决方案，解决了产品订单及销售问题。

到目前为止，卡奥斯 COSMOPlat 工业互联网平台已经在 15 个行业，12 个区域 7 大领域做到了推广复制。平台从家电领域自身的业务转型，扩

在国内疫情缓解之时，卡奥斯 COSMOPlat 平台升级为企业复工增产服务平台，通过企业复工全要素专区、疫情医护物资供需专区、居家保障专区三大系统。

展到产业链上下游行业生态，到 15 个互联工厂，进一步扩展到包含模具、机械、房车、服装等等在内的 15 个行业生态。另外，平台现有 7 大中心、12 个示范基地，覆盖 12 个区域、20 多个国家。COSMOPlat 工业互联网平台将大规模定制的模式解构为智能制造、模块采购、协同研发、交互定制等七大模块。通过灵活订阅、连接嵌套的模式，创新对用户的服务能力。

Haier Digital Technology: Make Digitization the Engine for Development in the Context of the Epidemic

Haier Digital Technology (Qingdao) Co., Ltd. (hereinafter referred to as "Haier Digital Technology") is a wholly-owned subsidiary of Haier COSMOPlat. It is mainly engaged in technology development, technology consulting, technology transfer and technology services in the sectors of digital technology, intelligent technology, software technology and Internet technology.

Haier Digital Technology is now implementing cross-industry ecological services. It provides full-cycle and zero-distance integrated ecological services ranging from interactive customization, R&D to logistics, services through the Industrial Internet platform applications. Standardized and customized solutions are available at each node. The core service plan is expected to enhance the overall operating efficiency of the enterprise by 5% to 10%, which is estimated to save the manufacturing industry hundreds of billions of cost.

At present, the COSMOPlat platform is stretching itself from the home appliance industry to other industries. Through seven modular solutions, namely user interaction, R&D innovation, collaborative procurement, smart manufacturing, smart logistics, accurate marketing and smart services, "plug-and-play" selective solution or full-process solution applications can be adopted to raise the whole process competitiveness of the SMEs and finally to achieve quality improvement and efficiency enhancement, resource allocation and model transformation. Now, COSMOPlat has been extended to 15 industry ecologies including machinery, molding, clothing, electronics, pottery, energy, RV, agriculture, healthcare and chemistry. The platform enables enterprises, various resources and users to interact,

create value, experience iteration and share added value. It empowers SMEs to up-grade and transform and maximizes the value of stakeholders.

Digital Platform to Assist Epidemic Control and the Resumption of Work and Production

At the outbreak of COVID-19 in 2020, a COSMOPlat creator encountered difficulties in purchasing masks and discovered that ordinary medical masks were in short supply across the nation. The general public and frontline medical workers were hard to make basic protection against the epidemic. The COSMOPlat creator quickly collaborated with other 3 creators and integrated the COSMOPlat R&D team to launch a platform for information sharing of COVID-19 epidemic medical supplies and resource convergence after 2 days and nights of argumentation, R&D and testing. The platform helped to fight the epidemic and safeguarded people by assisting to match the supply and demand of epidemic supplies needed by enter-prises to resume work and it empowered producers of epidemic prevention supplies to increase their production capacity. The platform made it possible to get timely, accurate and zero-distance interconnection of supply and demand messages of epi-demic prevention materials. It helped match the needs of epidemic areas with ma-terials of enterprises with greater precision and efficiency, while it also provided data support for government to deploy materials, which greatly safeguarded the materials in the epidemic areas. The self-organization and self-evolution under the "employee and order integration" model had validated the successful launch of the platform, which demonstrated the multifaceted synergy of enterprises linking gov-ernments and resources in upstream and downstream industry chains. It reflected the advantages of COSMOPlat for digital mass customization in the Industrial Internet era. COSMOPlat empowered a number of relevant medical institutions during the epidemic.

Digital Platform Assist Enterprises to Increase Production and Enhance Efficiency in the Post−epidemic Era

As the epidemic eased in China, COSMOPlat was upgraded to a service platform for enterprises to resume work and increase production. It set up three major systems including a special area for enterprises to resume work, a special area for supply and demand of epidemic medical and nursing supplies and a special area for home protection to meet the needs of enterprises, hospitals, schools, governments and other organizations for epidemic prevention and control and the needs to resume work and increase production. The platform had served nearly 500 enterprises and government departments in 10 days since its launch. It offered information support for enterprises to resume work and it reduced the workload of information collection for government managers. COSMOPlat focused on five major links: people, machinery, materials, methods and the environment, and it created 16 scenario solutions to empower enterprises with all elements, all process−es and all industrial chains. The platform output a "hardcore guide" for enterprises to ensure safety against the epidemic, guarantee the resumption of work and in−crease production.

From the initial supply and demand platform for the enterprise, the service platform for work resumption and production improvement, the platform of the entire medical material industry chain, to the latest new ecology of emergency materials, COSMOPlat has closely followed the demands of users at every step. The platform mainly adopts the coordinated ecological model of online digital platform + offline smart park to build an Industrial Internet platform with full−process, full−element, multi−level and continuous iteration. It takes a us−er−centered approach to realize the empowerment of the entire industry chain, and through the aggregation of resources, integration of online and offline, it real−izes whole−industry coupling, increase ecological value, and ultimately achieve a win−win situation for all stakeholders in the ecology. Take a practical case for in−

stance, COSMOPlat integrated the digital supply chain operating system of various industries, relying on which, Longfei Medical efficiently and accurately completed the deployment of core production lines, equipment, raw materials and other production resources, and through smart and customized solutions the company solved product orders and sales issues.

So far, the COSMOPlat Industrial Internet Platform has been promoted and replicated in 15 industries, 12 regions and 7 major sectors. After transition from the original business of home appliances, the platform has been stretched out to the upstream and downstream industry ecosystems of the industrial chain, to 15 interconnected factories, and further expanded to 15 industry ecosystems including molding, machinery, RV, clothing, etc. In addition, there are currently 7 centers and 12 demonstration bases of the platform, covering 12 regions and over 20 countries. The COSMOPlat Industrial Internet Platform decomposes the mass customization model into seven modules including intelligent manufacturing, module procurement, collaborative R&D, and interactive customization. The platform innovates the service capabilities for users through flexible subscription and connection nesting mode.

Entering the implementation stage of "Digital Equipment 2.0", Dongfeng Equipment is gradually solving many painful problems in industrial sites.

新华胶丝厂：
走出基于工业互联网的数字化转型之路

广东省江门市新会区新华胶丝厂有限公司（以下简称"新华胶丝厂"）成立于 1984 年，主营产品为工业单丝，产品主要覆盖 PPS 单丝、抗静电单丝、柳叶型单丝等 10 大门类，产品品质在国内处于领先水平，年产量超过 2500 吨。2020 年，为消弭新冠肺炎疫情影响，同时也为加快推动企业高质量发展，提升企业核心竞争力，新华胶丝厂寻求智能云科信息科技有限公司华南区域业务公司江门云科智能装备有限公司（以下简称"江门云科"）帮助，上线了智能云科 iSESOL WIS（工厂数字化制造运营系统）产品，实现了企业数字化、智能化转型升级。

企业转型背景

此前，新华胶丝厂的生产模式为按单生产，生产管理主要凭经验。企业规模的不断扩大，给设备、车间管理提出了新的要求，企业在管理方面的短板和痛点逐渐显现，亟待通过数字化转型来适应当前的发展形势。具体痛点包括：

生产管理层面：企业车间工况复杂，现场生产数据、运行数据采集难度大，生产报告难出；生产任务不透明，无法及时反馈，无法准确评估交期；传统纸质文档和电子文档管理混乱，种类多、核对难，要求生产管理人员有丰富的管理经验，对人员的依赖性较大。

质量管理层面：企业主要通过人工操作质量检测设备，对产品进行质量检验，质检效率低；主要通过纸质表格或检测报告进行质量数据收集，质量数据与生产数据未进行有效的关联，无法形成有效的追溯。

仓储管理层面：企业仓库通过进销存软件进行管理，只能管理物料库存，无先进先出提醒，无安全库存预警，存在货实不符的情况；无法实现

实现质量管理全流程管控，正反向质量追溯，人员、设备、产品良品率实时统计与监控。有效提升产品质量，降低产品不良率至2%。

库区库位精细管理；在生产计划下发后，无法有效实现物料划分或分配占用，影响计划执行的准确性。

成本管理层面：企业电能能耗、物料消耗、废丝等成本无法准确分摊到销售订单、产品、设备等不同环节，只能统计总量，因此无法进行精细化的成本管理。

针对企业的种种痛点和数字化转型需求，智能云科基于 iSESOL 工业互联网平台智能物联硬件与上云软件服务，帮助企业实现设备上云、生产管理可视化、订单协同、质量追溯、仓储管理等服务模式的智能化，助力新华胶丝厂打造数字化工厂。

企业转型概况

通过在新华胶丝厂实施 iSESOL BOX（智能魔盒）与 iSESOL WIS（工厂数字化制造运营系统），以 iSESOL 设备联网与数据采集能力为基础，串联销售订单管理、采购管理、设备管理、工艺管理、生产管理、能耗管理、质量管理、仓储管理等模块，实现涵盖从销售订单创建、计划自动分解（物料需求计划、生产月/周/日计划）、生产任务自动排程到车间生产加工等的全流程数字化、智能化管理。

同时，打造基于生产运行、维护运行、质量运行和库存运行等不同模块的智能应用产品，为企业提供从设备、生产现场到工厂管理全方位的应用服务，充分利用智能化的手段，助力企业达到提高生产效率、降低生产成本、精细生产管理的目标。

企业转型成效

新华胶丝厂通过主动拥抱数字化转型，打破了企业内部"信息孤岛"，实现了生产、计划、质检、仓储等多方面管理提升。具体成效包括：

1.生产信息实时掌握

通过实时采集生产现场设备、物料、人员、工时、工装、刀具、工艺、能耗等相关数据，以车间看板的方式实时监控生产全过程，包括车间设备运行状况、生产进度、产线产量、能耗使用等。通过 WIS 系统采集生产设

备参数记录，数据完整性提高了数十倍，减少了 2 个人力。

2.计划排程合理高效

实现对生产计划、销售计划、物料计划的合理安排，交货答复准确率 100%，排程效率提高 2 倍，排程结果有效性提高 80%，对市场的反应更快，提高企业综合实力与市场竞争力。

3.质量检测全程追溯

实现质量管理全流程管控，正反向质量追溯，人员、设备、产品良品率实时统计与监控。有效提升产品质量，降低产品不良率至 2%；实现生产实时数据保存，追溯效率提高 3 倍；在实时数据的告警提示下，参数异常处理及时性提高 2 倍。

4.仓储管理有序透明

实现仓储管理有序透明，通过 PDA 扫描进出库准确率达到 100%；发货准确率达到 100%，发货效率提高 4 倍；月结工作效率提高 2 倍。实现了供应链上下游采购、供应和生产运营的协同。

Sunward (XinHui) Monofilament Factory: Find Its Way toward Digital Transforma−tion Based on the Industrial Internet

Sunward (XinHui) Monofilament Factory Co., Ltd (hereinafter referred to as "Sunward (XinHui) Monofilament Factory") was established in 1984 in Xinhui District, Jiangmen City, Guangdong Province. It is engaged in industrial monofil−aments, and its products mainly cover 10 classifications including PPS monofila−ment, antistatic monofilament, and willow leaf. Its products quality is at the leading level in China, with an annual output of more than 2500 tons. In 2020, in order to reduce the impact of the COVID−19, but also to accelerate the high−quality de−velopment and the core competitiveness of the enterprise, Sunward (XinHui) Monofilament Factory seeks help from Jiangmen iSESOL Equipment Co., Ltd. (hereinafter referred to as "Jiangmen iSESOL"), which is the business sector of iS−ESOL Information and Technology Co., Ltd. in the South China, to launch the iSESOL WIS (operation system for factory digital manufacturing), with which the company has realized the digital and intelligent transformation and upgrading.

Enterprise Transformation Background

Previously, Sunward (XinHui) Monofilament Factory made productions by order and it managed production mainly according to its experience. As the company scale expanded, new requirements were put forward for the management of equipment and workshops, and the shortcomings and sore points of the enterprise in management gradually showed up, which called for company＇s urgent digital transformation to respond to the current growing situation. Specific sore points include:

Sunward (XinHui) Monofilament Factory Co., Ltd (hereinafter referred to as "Sunward (XinHui) Monofilament Factory") was established in 1984 in Xinhui District, Jiangmen City, Guangdong Province.

Production management: complex workshop conditions in the company, difficulty in collecting on-site production data and operational data, and difficulty in making production reports; opaque production tasks, unable to provide timely feedback, unable to accurately assess delivery dates; chaotic management of traditional paper documents and electronic documents, and numerous types of documents and difficulty in checking needed high dependence on personnel and also required production managers to possess extensive management experience.

Quality management: The company mainly relied on manual operation to conduct product quality inspection on quality inspection equipment, which resulted in low inspection efficiency; the company collected quality data mainly through paper forms or inspection reports, and quality data and production data were not effectively correlated, which resulted in ineffective traceability.

Warehouse management: The company managed warehouse on the inventory software, which could only help to manage material inventory, without FIFO reminder nor safety stock warning, so there was the situation that the inventory did not match the reality; fine management of the storage area and storage position could not be achieved; after the production plan was released, failure in effective material division or allocation affected the accuracy of the plan implementation.

Cost management: Refined cost management was not available as the cost of electrical energy consumption, material consumption and waste silk could not be accurately apportioned to different links such as sales orders, products and equipment, for which only a total cost amount could be generated.

Considering the various sore points and digital transformation needs of the company, iSESOL assisted the company to achieve equipment on the cloud, production management visualization, order collaboration, quality tracing, warehouse management and other services mode of intelligence with the aid of IIOT hardware and cloud software services on the iSESOL Industrial Internet Platform, supporting Sunward (XinHui) Monofilament Factory to create a digital factory.

Enterprise Transformation Overview

Through the implementation of iSESOL BOX and iSESOL WIS in Sunward (XinHui) Monofilament Factory, and on the basis of iSESOL's equipment networking and data collection capabilities, the modules including sales order management, procurement management, equipment management, process management, production management, energy consumption management, quality management and warehouse management are linked together to execute the digital and intelligent management of the entire process from sales order creation, automatic planning breakdowns (material requirement planning, monthly/weekly/daily production planning), automatic scheduling of production tasks to workshop manufacturing and processing.

At the same time, we create smart application products for different modules such as production operation, maintenance operation, quality operation and inventory operation to provide the company with a full range of application services from equipment, production site to factory management, and make full use of intelligent means to help the company improve production efficiency, lower production costs and refine production management.

The Effect of Enterprise Transformation

By actively embracing digital transformation, Sunward (XinHui) Monofilament Factory has broken down the "information silos" within the enterprise and it has achieved various management improvements in manufacturing, planning, quality control and storage. Specific results include:

1. Master real-time production information

Through real-time collection of production site data including equipment, materials, personnel, working hours, tooling, cutting tools, processes and energy consumption, the whole production process is monitored in real time via workshop board, including workshop equipment operation status, production progress,

production line output and energy consumption usage. Data integrity is increased by dozens of times and 2 manpower costs are saved with the production equipment parameter records collected by the WIS system.

2. Rational and efficient scheduling

Realize rational arrangement of production plan, sales plan and material plan. Delivery reply reaches 100% accuracy, scheduling efficiency increases by 2 times, and validity of scheduling results is 80% higher. The company owns faster response to the market, and its comprehensive strength and market competitiveness are thereby improved.

3. Full traceability of quality testing

Realize full process control of quality management, positive and negative quality tracing, and real−time statistics and monitoring of personnel, equipment and product yield. Effectively improve product quality and lower product defect rate to 2%; achieve real−time production data preservation and improve traceability effi− ciency by 3 times; promote parameter abnormality processing timeliness by 2 times under the alarm prompt of real−time data.

4. Orderly and transparent storage management

Orderly and transparent warehouse management is realized, and the accuracy rate of entering and leaving the warehouse through PDA scanning reaches 100%; the delivery accuracy rate hit 100%, and the delivery efficiency is increased by 4 times; the monthly settlement efficiency is improved by 2 times. Coordination of upstream and downstream procurement, supply, and production operations in the supply chain is finally achieved.

Realize rational arrangement of production plan, sales plan and material plan. Delivery reply reaches 100% accuracy, scheduling efficiency increases by 2 times, and validity of scheduling results is 80% higher.

双环传动：
打造智能制造领域的"5G+工业互联网"典范

双环传动集团作为全球领先的汽车传动高端部件供应商，深刻意识到资源和内外部环境约束不断强化，劳动力等生产要素成本不断上升，投资和出口增速明显放缓，主要依靠资源要素投入、规模扩张的粗放发展模式难以为继，加快探索推进工厂 OT 技术域和企业 IT 业务域深度融合，建设和发展工业互联网推动工厂 OT 技术域和企业 IT 业务域融合，调整产业结构、数字化转型升级、提质增效刻不容缓。

以数字化、网络化、智能化为主要特征的新工业革命的关键基础设施，从网络、数据、流程和服务等 4 个层面打破工厂"信息孤岛"，促进集成共享，更大范围、更高效率、更加精准地优化生产和服务资源配置，促进传统产业转型升级，催生新技术、新业态、新模式，为制造强国建设提供新动能，成为双环传动集团发展重要战略方向。

数字化转型升级之路

为此，双环传动积极推进工厂车间应用系统建设，致力于建成一个集产品设计、工艺制定、加工制作、生产管理、质量控制等于一体的智能制造工厂，实现从传统制造到智能制造新模式的产品设计、生产加工、识别检测、能源监控的全流程智能化。公司积极推进工厂车间应用系统建设，搭建多个管理系统及平台，有效支撑了数字化车间的生产制造和日产运营管理。并且拥有独立自主的软件研发应用团队。两年时间，公司根据自身需求的扩充，先后自主研发出双环 D-MOM 平台，实现了以精益生产为目的供应链高效管理，把企业有关产品的质量、产量、成本等相关的综合生产指标目标值转化为制造过程的作业计划、作业标准和工艺标准，实现生产制造管理精细化。达到了科学管理、提高效率、降低成本的目的，完成

双环传动集团作为全球领先的汽车传动高端部件供应商，深刻意识到资源和内外部环境约束不断强化，劳动力等生产要素成本不断上升，投资和出口增速明显放缓。

了由"制造"向"智造"的转变。

另外，2020 年，双环传动联合北京数码大方科技股份有限公司，将 CAXA 工艺管理系统与双环 D-MOM 平台进行集成，打通从设计工艺到生产工艺的数据孤岛，通过系统集成将工艺人员制作的 CAXA 图面直接转换为 D-MOM 系统中结构化数据，实现了产品设计、工艺变更、工艺下发、工艺审批等全流程的工艺管控，完成了产品从设计到生产的高效协同。

"5G+ 大数据平台"打造参数级智能工厂

通过大数据平台技术，打破产业链大数据孤岛，数据驱动企业运营和业务模式创新，助力双环在快速响应市场变化、提升产品质量和价值、缩短产品交付周期和降低企业运营成本等 4 个方面数字化升级转型：

1)采用通过 PLC、SCADA、DCS 等系统从机器设备实时采集数据，也可以通过支持 MQ/SOAP 等数据交换接口从实时数据库等系统批量同步的方式获取物联网数据。同时还需要从业务系统的关系型数据库、文件系统中采集所需的结构化与非结构化业务数据，形成边缘数据治理层。

2)采用元数据、ETL 和特征工程等技术，从市场营销、产销协调、工艺设计、生产计划、生产执行、产品审验、仓储管理、物流管理、售后服务等全生命的信息化系统，提取客户主数据、渠道主数据、订单主数据、产品主数据、计划 BOM 数据、工艺 BOM 数据、执行 BOM 数据、质量 BOM 数据、物流 BOM 数据和服务 BOM 数据等，形成双环数字运营平台的数据层。

3)采用大数据分析、人工智能和知识图谱等技术，从客户主数据、渠道主数据、订单主数据、产品主数据、计划 BOM 数据、工艺 BOM 数据、执行 BOM 数据、质量 BOM 数据、库存 BOM 数据、物流 BOM 数据和服务 BOM 数据等，以"数据驱动 + 机理驱动"的双驱动模式来进行工业大数据的分析，从而建立高精度、高可靠性的模型来真正解决实际的工业问题，覆盖客户、订单、工艺、计划、研发、生产、仓储、物流和服务等分析、决策、判断和预警等智能机理模型。建立状态感知—实时分析—自主决策—精准执行的智能模型层。

4) 采用 SaaS 技术，构建面向产品全生命周期的智能服务门户，通过对产品运行的实时监测，提供远程维护、故障预测、性能优化等一系列服务，开展数字交易，降低企业运营成本，并反馈优化产品设计，通过 IT 与 OT 的融合将实现企业动态互联、资源优化配置、业务精准协作的愿景，能有效推动制造业质量变革、效率变革、动力变革，成为新工业革命的关键支撑和深化"互联网 + 先进制造业"的重要基石，助力工业企业开展数字化转型，实现高质量发展。

Shuanghuan Driveline: Building a Model of "5G+Industrial Internet" in the Field of Intelligent Manufacturing

An important strategic direction for Shuanghuan Driveline is promoting the transformation and upgrading of traditional industries, enabling new technology, new industry, and new modes to provide new momentum for making China into a strong manufacturing country.

As a leading global supplier of high−end automotive transmission compo−nents, Shuanghuan Driveline is fully aware that, with the strengthening restraints of resources and internal and external environment as well as rising cost of labor and other factors of production, investment and export growth has slowed signifi−cantly. The extensive development model relying mainly on resource inputs and scale expansion can no longer be sustained. Thus, we are in urgent need to accel−erate integration of factory OT technology and enterprise IT business, promote industrial structure, digital transformation and upgrading, and improve quality and efficiency.

An important strategic direction for Shuanghuan Driveline is promoting the transformation and upgrading of traditional industries, enabling new technology, new industry, and new modes to provide new momentum for making China into a strong manufacturing country. With digitalization, networking and intelligence as its main features, the key infrastructures built up in the new industrial revolution have broken the "information islands" of factories from four levels including network, data, process and service. It promoted integration and sharing, and optimized the allocation of production and service resources in a broader, more efficient and accurate way.

The road to digital transformation and upgrading

To this end, Shuanghuan Driveline actively promoted the construction of factory workshop application system, and is committed to building an intelligent

manufacturing factory integrating product design, process formulation, processing and production, production management and quality control, and realizing the upgrade from traditional manufacturing to the new model of intelligent manufacturing, which covers the whole process of product design, production and processing, identification and testing, and energy monitoring. Besides, the company actively promoted the construction of factory workshop application system and built several management systems and platforms, which effectively supported the digital workshop manufacturing and daily production operation management. It also has an independent and autonomous software development and application team.

In two years, the company has independently developed its D-MOM platform, which realized the efficient management of supply chain for the purpose of lean production and transformed the target values of comprehensive production indexes related to the quality, output and cost of products of the enterprise into the operation plan, operation standard and process standard of the manufacturing process, so as to realize the refinement of production and manufacturing management. In this way, it has achieved the purpose of scientific management, efficiency and cost reduction, and completed the transformation from "manufacturing" to "intelligent manufacturing".

In addition, in 2020, Shuanghuan Driveline, together with CAXA, integrated CAXA process management system with Shuanghuan's D-MOM platform to open the data silo from design process to production process, directly converting CAXA drawings made by process personnel to structured data in D-MOM system. Through system integration, CAXA drawings made by process personnel are directly converted into structured data in the D-MOM system, realizing the control of design, change, issuance, and approval of processes and completing the efficient collaboration from design to production.

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Building a parameter–level smart factory based on "5G + big data platform"

Based on the big data platform, it broke the big data silo in the industry chain and helped driving the enterprise operation and business model innovation with data. This has helped Shuanghuan to achieve digital upgrade in four areas: responding quickly to market changes, improving product quality and value, shortening product delivery cycles and reducing business operating costs.

1) IoT data is acquired by real–time data collection from machines and equipment through PLC, SCADA and DCS and by batch synchronization from real–time databases through data exchange excuses such as MQ/SOAP support. The required structured and unstructured business data can be obtained from the relational database and file system of the business system to form the edge data governance layer.

2) With the help of metadata, ETL and feature engineering technologies, customer master data, channel master data, order master data, product master data, planning BOM data, process BOM data, execution BOM data, quality BOM data, logistics BOM data and service BOM data are extracted from the whole–life cycle information systems to form the data layer of Shuanghuan's digital operation platform. The information systems cover marketing, production and sales coordination, process design, production planning, production execution, product auditing, warehousing management, logistics management, after–sales service.

3) Drawing on big data analysis, artificial intelligence and knowledge mapping technologies, as well as customer master data, channel master data, order master data, product master data, plan BOM data, process BOM data, execution BOM data, quality BOM data, inventory BOM data, logistics BOM data and service BOM data, a model driven by both data and mechanisms is used to analyze industrial big data. It has also established highly precise and reliable model that solve actual industrial problems, covering intelligent mechanism models for analysis,

decision−making, judgment and early warning of customers, orders, processes, plans, R&D, production, warehousing, logistics and services. Besides, an intelligent model layer of state perception − real−time analysis − autonomous decision making − accurate execution has also been established.

4) It has built an intelligent service portal covering the whole life cycle of products by SaaS technology. Through real−time monitoring of product operation, it provides various kinds of services such as remote maintenance, fault prediction, and performance optimization, facilitates digital transactions, and helps reducing business operation costs and optimizing product design according to the feedback. The integration of IT and OT will help fulfilling the vision of dynamic interconnection of enterprises, optimal resource allocation and precise business collaboration. It can promote the transformation in quality, efficiency and power of the manufacturing industry, act as an important supporter of the new industrial revolution and cornerstone in deepening the revolution of "Internet + advanced manufacturing industry". Moreover, it can help industrial enterprises move toward digital transformation and achieve high−quality development.

利欧：构建工业互联网平台，助力企业数字化转型升级

当前，全球制造业正从数字化阶段向网络化阶段加速迈进，工业互联网平台迅速兴起成为工业格局的聚焦点，作为新一代信息通信技术与现代工业技术深度融合的产物，成为制造业数字化、网络化、智能化的重要载体。工业互联网依托大数据，承载着系统打通、优化工业生产流程的使命，对带动企业生产成本降低和效率提升具有划时代的重大意义。近年来，利欧全力推进两化融合、智能制造、企业上云，大力构建工业互联网平台，推动企业数字化转型升级，实现做精、做强、做大的战略目标。

打造数字化工厂 生产走向自动化

作为国家智能制造试点示范企业，自 2015 年开始，利欧将生产车间打造成数字化工厂，包括注塑、压铸、组装、电机、转子、检测等多个环节实现自动化。目前，已经完成自动化总装生产线样线的研制、自动化零部件精加工生产样线的研制、零部件铸造和注塑自动生产样线的研制、物联网系统中的注塑件加工物联网试点系统建设、质量追溯管理系统软件开发、工艺监控分析系统软件开发等。

在这个数字化工厂里，利欧用自主设计开发的上下料机械手和自动送料设备代替人工操作，减少了人的走动时间和拿取物料等非增值时间；自动化总装生产线实现少人化生产，物联网技术实时采集制造过程中每个车间、每台设备、每个检测结果，实现产品从设计、加工、检测到装配的全流程智能化、数字化管理。

目前，这个数字化工厂的关键设备智能化率达到 83.6%，制造过程的数控化度达到 86%，生产效率提高 56%；通过电机自动化生产线与自动化装夹机械手，减少人员 46% 以上；产品不良品率降低 12%，能源利用率提高 45%，运营成本降低 30%。

作为国家智能制造试点示范企业，自 2015 年开始，利欧将生产车间打造成数字化工厂，包括注塑、压铸、组装、电机、转子、检测等多个环节实现自动化。

此外，利欧也将利用物联网技术，通过每条生产线的终端采集器，将制造过程中的每个车间、每台设备、每个检测结果进行实时采集，实现产品从设计、加工到检测、装备的全流程智能化、数字化管理。

构建工业互联网平台 助推转型升级

利欧，作为各类泵（电机）的研发、生产、销售和服务企业和高新技术企业，着力推进信息化、精益化管理，全流程智能化，提高产业链各个环节的增值能力。在国家大力推进工业互联网平台发展的背景下，利欧作为行业的领军企业，积极推进企业工业互联网平台的建设工作，依托已有的资源优势和核心技术，抢占高端市场竞争制高点。

目前，公司着力推进"三大平台"的建设，以满足制造业数字化、网络化、智能化需求，为企业构建基于海量数据采集、汇聚、分析的服务体系，帮助泵产业链上下游公司实现安全、提质、降本、增效、环保的目标。

一是车间物联网子平台建设，通过物联网技术将制造过程中的每个车间、每台设备、每个检测结果进行实时采集，实现产品从设计、加工、检测、装配的全流程智能化、数字化管理。二是运营管理子平台建设，通过以 ERP 系统为核心，集成 PLM 系统、供应商关系管理 SRM、客户关系管理 CRM 系统、协同办公 OA 系统，实现泵（电机）产业链上下游单位间供需协同，实现制造过程严格受控，供应链从响应／反应式制造到预测制造。三是智能决策子平台建设，通过构建智能决策 BI 系统，基于采集的业务运行、客户服务、供应链协同等数据，通过大数据分析，帮助产业链上下游企业更高效地进行决策。

截至目前，利欧工业互联网平台目前试运行正常，用户反映良好，效益逐渐显现，影响力明显增强。未来，利欧将在工业互联网平台运营成熟的基础上，将其接入政府建设的"1+N"的平台体系中，同时在政府的推动下，在行业和区域内进行推广，促进泵行业企业上下游产业链生态圈数字化、网络化、智能化发展。

目前，公司着力推进"三大平台"的建设，以满足制造业数字化、网络化、智能化需求，为企业构建基于海量数据采集、汇聚、分析的服务体系，帮助泵产业链上下游公司实现安全、提质、降本、增效、环保的目标。

LEO:
Create an Industrial Internet Platform to Assist Digital Transformation and Pro-motion of the Enterprise

At present, the global manufacturing industry is accelerating the step from the digital stage to the networked stage, and the industrial internet platform is rapidly emerging as the focus of the industrial landscape. As a result of the in-depth integration of a new generation of information and communication technology and modern industrial technology, the platform has become a significant carrier for the digitalization, networking and intelligence of the manufacturing industry. Relying on big data, the Industrial Internet bears the mission of systematically opening up and optimizing industrial production processes, which is of epoch-making significance in driving down manufacturing costs and improving efficiency of enterprises. In recent years, LEO has made every effort to promote the integration of informatization and industrialization, intelligent manufacturing, enterprise cloudification, and the company has strived to create an industrial Internet platform to facilitate its digital transformation and upgrading, finally to achieve its strategic goal of being more refined, stronger and larger.

Create a Digital Factory for Automated Manufacturing

As a pilot demonstration enterprise for national intelligent manufacturing, LEO has been transforming its production workshop into a digital factory since 2015, and many links have realized automation including injection moulding, die-casting, assembly, motor, rotor and testing. At present, it has completed R&D in the prototype lines of automated assembly production line, the prototype lines

of automated parts finishing production and the prototype lines of automated parts casting and injection moulding production, and it has accomplished the construction of its digital factory, including the establishment of a pilot IoT system for injection moulded parts processing, the software development of quality tracing management system and the software development of process monitoring and analysis system.

In this digital factory, LEO replaces manual operations with independently designed and developed loading and unloading manipulator and automatic feeding equipment, which saves worker walking time and non-value-added time such as picking up materials; the automated assembly line enables flexible manpower production, and intelligent and digital management is realized in the whole process of manufacturing from design, processing, testing to assembly with the help of IoT technology to collect real-time data of every workshop, every piece of equipment and every test result in the manufacturing process.

At present, the key equipment in this digital factory has reached an intelligentization rate of 83.6%, the numerical control degree of the manufacturing process has risen to 86%, and the production efficiency has been increased by 56%; the motorized production line and the automated clamping manipulator has reduced the number of personnel by more than 46%; the defective product rate has been lowered by 12%, the energy utilization rate has been improved by 45%, and the operating cost has been decreased by 30%.

In addition, LEO will utilize the IoT technology to collect real-time data from each workshop, each set of equipment, and each test result in the manufacturing process through the terminal collector of each production line, so as to realize its intelligent and digital management in the whole process from design, processing, testing to assembly. It will set up an industrial Internet platform to drive its transformation and upgrading

As an enterprise specialized in R&D, production, sales and service of various pumps (motors) and also as a high-tech enterprise, LEO is dedicated to promoting

informationization, lean management, intellectualization of whole process, and improving the value−added capability of each link of the industrial chain. Under the national vigorous promotion of industrial Internet platform, LEO, as a leading enterprise in the industry, is actively implementing the construction of enterprise industrial Internet platform, and it is utilizing the existing resource advantages and core technology to seize the high point in the high−end market competition.

At present, the company gives priority to the construction of "three platforms" to meet the digital, networked and intelligent needs of the manufacturing industry. It is to build a service system based on massive data collection, aggregation and analysis to facilitate the enterprises upstream and downstream of the pump industry chain to achieve the goals of safety, quality improvement, cost reduction, efficiency increase and environmental protection.

The first is to construct a workshop IoT sub−platform. Use IoT technology to collect real−time data from each workshop, each set of equipment, and each test result in the manufacturing process, so as to realize intelligent and digital management in the whole process from design, processing, testing to assembly. The second is to set up a sub−platform for operation management. Make use of ERP system as the core, together with PLM system, SRM system, CRM system and OA system, to realize the coordination of supply and demand between the upstream and downstream companies of the pump (motor) industry chain, and to achieve the strict control of the manufacturing process, and to turn the supply chain from responsive/reactive manufacturing to predictive manufacturing. The third is to establish a sub−platform for intelligent decision making. Via intelligent decision−making BI system, and on the basis of the collected data of business operation, customer service, supply chain synergy, etc., the platform is to facilitate the upstream and downstream enterprises in the industry chain to make decisions more efficiently through big data analysis.

As of now, the LEO Industrial Internet Platform is in normal trial operation. It has received sound user response. The benefits have gradually emerged and the

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impact has amplified significantly. In the future, LEO will integrate the industrial Internet platform into the "1+N" platform system built by the government as its platform grows mature. At the same time, under the promotion of the government, the platform will be popularized in the industry and region to drive the digital, networked and intelligent development of the upstream and downstream industrial chain ecosystem of the pump industry enterprises.

浙江安露：智能制造引领企业数字化转型

浙江安露清洗机有限公司（以下简称浙江安露）成立于1997年，是一家从事清洗机领域研发、生产、销售以及服务于一体的高新技术企业，是浙江省级高新技术企业及省级专利示范企业，是国内高压清洗机生产的领军企业。

近年来，浙江安露从行业领军地位和产品竞争力的持续保持需求等发展战略目标出发，作出了"数字化转型、建设未来工厂"的发展目标，为此进行了积极探索和实践，并取得了一些成果。

智能化生产

（一）引进智能设备。通过购置机械手、更新智能化设备，在设备上安装物联网终端等手段，在精加工车间率先完成数字化改造；通过设备物联方式，将设备运行数据实时上传到云服务器，再实时投送到车间大屏幕，实现了从生产计划、生产进度、设备运行、产品质量等阶段全程数字化管理。

（二）开发智能装备。组建智能装备研发团队，自主研制切实符合企业实际需求的智能设备；引进智能物流，完善企业信息化系统的整合。物联网的实施，实现设备网络化，生产数据自动采集、分析，协助采购、计划调度、生产作业、仓储配送部门的数据分析和执行，提高生产计划准确性和生产过程的可控性。

数字化车间投入运行后，企业的运营成本、产品不良率、生产效率和能源利用率等方面都得到了显著的优化。据统计，数字化车间投入运行后，车间所需员工减少约23%，全员劳动生产率上升了26%，产品合格率提高了约5个百分点，产品一次合格率达99%以上。

企业致力于研发生产智能化产品。通过安露工业互联网平台，实现信息数据资源的交互共享。

智能化管理

截至目前，企业已导入信息化管理软件有 ERP、PLM、MES、WMS、OA、HR 等管理软件，构建了安露企业数据大脑，包含数据管理中台和数据分析大脑应用平台。安露企业数据大脑，主要服务于智能制造数字化车间及洗车机智能运营运维两大系统，实现了产品研发、制造、运维端对端产品全生命周期业务集成及制造企业、渠道、运维企业、客户应用的端对端价值集成。

通过建设企业数据大脑平台，利用智慧物联实时数据自动采集、边缘计算、大数据、云计算等抓手，提供给产品设计、技术支持、生产制造、以及销售和市场相关环节，完成静态数据与动态数据融合，实现数据驱动业务，贯通产品全生命周期管理；以数据挖掘、数据分析和数据预测为主的大数据服务，为渠道和自主运营提供给平台化应用服务，实现平台赋能、业态升级、生态组合来赋能智能制造、智能运营、智慧服务等；开展以服务型制造：智慧环卫、无人清洁车、智能洗车机、商用电动车、数据连接终端等模式的创新业务。

取得了以下几点成效。

一是采用工业互联网完成现有生产设备低成本数字化改造和联网。实现设备状态明、生产过程透明和人员绩效管理透明。提升设备使用效率 20%以上，人员绩效管理准确度达到 95%以上。该应用具备非常好的通用性，适合 70%的中小型离散加工制造型企业需求。

二是产品的数字化运营与运维。将互联网客户端与工业互联网产品制造端紧密结合，促进生产性服务的商业模式转变，将智能生产制造、产品运营与客户服务转型融合。形成了产品运营服务平台，收入规模以每年 100%的速度递增。针对生产装备和产品的企业具备很好的推广性和适用性。

三是产品追溯体系的形成。降低设备产品的维护维修成本 50%以上，通过对产品设计数据、制造数据、检验数据、维护维修数据和产品运营数据的融合，形成了完整的产品追溯体系。备品备件储备量降低了 30%，服务效率提升了 300%。针对高端产品的后服务市场具备很好的推广性。

智慧化产品

企业致力于研发生产智能化产品。通过安露工业互联网平台，实现信息数据资源的交互共享。供应链内及跨供应链间的企业实现产品设计、供应、制造和服务的协同生产。

目前，企业研发了一款无人智能洗车机。用户只需坐在车内，运行手机 APP，即可轻松洗车，无需人工操作。运营人员通过云后台，足不出户，即可掌握全国各个站点的运营情况，真正实现远程控制、远程故障检查维修等。未来，企业将继续对家用清洗机进行智能化开发，让智能化家用清洗机走进千家万户。

Zhejiang Anlu:
Intelligent Manufacturing Drives the Enterprise Digital Transformation

Founded in 1997, Zhejiang Anlu Cleaning Machinery Co., Ltd. (hereinafter referred to as Zhejiang Anlu) is a high−tech enterprise engaged in R&D, production, sales and service of cleaning machinery, which is a provincial high−tech enterprise and a provincial patent demonstration enterprise in Zhejiang. It is a leading enterprise in the production of high−pressure cleaning machines in China.

In recent years, starting from the growing strategy targets to remain industry leadership and maintain product competitiveness, Zhejiang Anlu has set "digital transformation and construction of future factory" as its developing goal. For this goal, the company has made active explorations and practice. Some results have been achieved.

It is a leading enterprise in the production of high−pressure cleaning machines in China.

Intelligent Manufacturing

(1) Introduce smart equipment. By purchasing manipulators, updating intelligent equipment, and installing IoT terminals on the equipment, the company has taken the lead in completing the digital transformation in the finishing workshop; by the means of the equipment IoT, the equipment operation data is uploaded to the cloud server in real time, and the data is sent to the workshop large screen promptly, for which the company realizes the digital management of the whole process from production planning, production progress, equipment operation, and product quality.

(2) Develop intelligent equipment. Organize an intelligent equipment R&D team to make independent development of intelligent equipment that meets the

actual needs of the company; introduce intelligent logistics to improve the integration of enterprise information systems. Implement IoT to realize equipment networking, automatic collection and analysis of production data, and to assist data analysis and execution in departments of procurement, planning and scheduling, production operations, and warehousing and distribution, and finally to improve the accuracy of production planning and enhance the controllability of the pro-duction process.

After the digital workshop was put into operation, the company's operating costs, product failure rate, production efficiency, and energy utilization have all seen significant optimization. According to statistics, after the digital workshop was started, the number of employees required for the workshop has been reduced by about 23%, the overall labor productivity has increased by 26%, the product pass rate has improved by about 5%, and the product first pass rate has been up to more than 99%.

Intelligent Management

Up to now, the company has introduced information management software such as ERP, PLM, MES, WMS, OA, HR, and it has built an enterprise data brain, including data management platform and data analysis brain application platform. Anlu enterprise data brain mainly serves two systems: intelligent manufacturing digital workshop and intelligent operation and maintenance of car washing machines, which has realized end-to-end product development, manufacturing, operation and maintenance, product lifecycle business integration, and end-to-end value integration of manufacturing enterprises, channels, operation and maintenance enterprises and customer applications.

With the enterprise data brain platform, the company provides product design, technical support, manufacturing, sales and marketing related links with smart IoT real-time data automatic collection, edge computing, big data, cloud computing and other tools. It completes the fusion of static data and dynamic data，

realizes data-driven business and integrates product life cycle management; big data services based on data mining, data analysis and data prediction offer platform-based application services to channels and independent operations, which enables platform empowerment, business format upgrade and ecological combination to empower smart manufacturing, smart operations, smart services, etc.; develop innovative services for service-oriented manufacturing: smart sanitation, unmanned cleaning vehicles, smart car washes, commercial electric vehicles, and data connecting terminals, etc.

The following results have been achieved.

The first is the completion of the low-cost digital transformation and networking of existing production equipment with the aid of the Industrial Internet. Clear equipment status, transparency in the production process, and transparency in personnel performance management are realized. Equipment use efficiency is improved by more than 20%, and personnel performance management accuracy is promoted to more than 95% . This application embraces excellent versatility and it is suitable for the needs of 70% small and medium-sized enterprises engaged in discrete processing and manufacturing.

The second is the digital operation and maintenance of products. The Internet client end is closely integrated with the industrial Internet product manufacturing end to promote the transformation of the business model of productive services, and to merge together the transformation of intelligent manufacturing, product operation and customer service. A product operation service platform has taken shape, and the scale of revenue has soared at an annual rate of 100%. The platform has outstanding promotion and applicability for companies that produce equipment and products.

The third is the formation of a product traceability system. Maintenance and repair costs of equipment and products are lowered by 50% or more. A complete product traceability system takes shape through the integration of product design data, manufacturing data, inspection data, maintenance and repair data, and product

operation data. The reserve of spare parts is decreased by 30%, while the service efficiency is enhanced by 300%. The system has excellent promotion for the af-ter-service market of high-end products.

Smart Products

The company is committed to developing and producing intelligent prod-ucts. It has made the interactive sharing of information and data resources possible through Anlu Industrial Internet Platform. Enterprises within the supply chain and across the supply chain have realized the collaborative manufacturing from product design, supply, manufacturing to services.

At present, the company has developed an unmanned intelligent car washing machine. Users only need to sit in the car and run the mobile APP to easily wash the car without manual operation. Through the cloud backend, operators can grasp the operation status of various sites across the country without leaving their homes, which makes true remote control, remote fault inspection and mainte-nance, etc. In the future, the company will make continuous efforts to develop intelligent household washing machines, making intelligent household washing machines available to ordinary people.

At present, the company has developed an unmanned intelligent car washing machine.

君业药业：
以智能制造赋能企业高质量发展

浙江仙居君业药业有限公司（以下简称君业药业）创始于 1998 年，以终为始地坚持"以君子品质，立百年基业"为全球制药企业提供甾体激素高级中间体和原料药以及创新性的工艺研发及规模化生产服务（CDMO），该平台目前正承载着来自全球近 20 个国家的 100 多家合作伙伴的甾体药物研发与生产。

医药行业是我国经济发展的重要组成部分，是推广应用智能制造的重点领域。由于涉及多种物料、多道工序，以及订单式的生产制造模式，传统制造在智能化推进过程中仍遇到不少困难。为此，亟须在传统行业进一步探索，逐步形成了一些可复制推广的智能制造经验和新模式，为智能制造进一步创新、应用和推进奠定基础。

数字化转型提速

基于新一代信息技术和先进制造技术，君业药业以在建项目为载体，以网络互联为支撑，以数字化贯通生产经营过程，通过工艺流程与车间布局的数字化建模，工序流程的优化运行与预测诊断，高度集成的产量、质量、能耗在线监测及诊断预测评估系统，与 ERP 高度协同集成的智能MES，实现整个生产过程的优化控制及供应链的优化管控，提高生产效率、降低运营成本和产品不良品率。

1.各反应罐均通过 DCS 系统自动控制温度、自动补料，工艺参数自动监测。萃取系统采用自动监测液位、自动进料、自动分离。精制、回收、干燥各工序均采取自动控制。关键装备数控化率达到 70% 以上，生产数据自动采集率达到 70%，装备水平达到同行业领先。

2.先进设备的使用降低了现场投料人员、操作人员数量，减少了人为

浙江仙居君业药业有限公司（以下简称君业药业）创始于 1998 年，以终为始地坚持"以君子品质，立百年基业"为全球制药企业提供甾体激素高级中间体和原料药以及创新性的工艺研发及规模化生产服务（CDMO）。

操作对生产的影响，使人工减少 50%，生产效率提升 50%。

3.由于人工成本的大幅降低、生产效率的提升，自动化、连续化、密闭化的操作减少了溶媒损耗，提高了设备利用率。加上变频器的大量使用，使各工序的高度协同化，各工艺参数精确控制，节能减排 40%，成本降低40%。

5G+ 技术赋能未来工厂

未来的工厂是数字虚拟和物理现实相融合，ICT 与现代制造业相融合，以提高工业生产的灵活性、可追溯性、多功能性和生产效率，为制造业开辟新的商业模式。

1、远程设备运维

在未来，工厂中每个物体都是一个有唯一 IP 的终端，使生产环节的原材料都具有"信息"属性。原材料会根据"信息"自动生产和维护。人也变成了具有自己 IP 的终端，人和工业机器人进入整个生产环节中，和带有唯一 IP 的原料、设备、产品进行信息交互。工业机器人在管理工厂的同时，人在千里之外也可以第一时间接收到实时信息跟进，并进行交互操作。

2、设备联网

随着工业互联网的发展，越来越多的车间设备，如机床、机器人、AGV 等开始接入工厂内网，尤其是 AGV 等移动设备的通信，有线网络难以满足，对工厂内网的灵活性和带宽要求越来越高。传统工厂有线网络可靠性带宽高，但是灵活性较差，无线网络灵活性较高，但是可靠性，覆盖范围，接入数量等都存在不足。兼具灵活性、高带宽和多终端接入特点的5G，成为承载工厂内设备接入和通信的新选择。

3、质量控制

基于 5G 的大带宽低时延，通过 5G+AI+ 机器视觉能够观测微米级的目标；获得的信息量是全面且可追溯的，相关信息可以方便地集成和留存，从而改变整个质量检测的流程。

4、可视化工厂

5G 技术能够为智能工厂提供全云化网络平台。精密传感技术作 用于不

计其数的传感器，在极短时间内进行信息状态上报，大量工业级数据通过 5G 网络收集，庞大的数据库开始形成，工业机器人结合云计算的超级计算能力进行自主学习和精确判断，给出最佳解决方案，真正实现可视化的全透明工厂。

5、物流管理

在 RFID、EDI 等技术的应用下，智能物流供应的发展几乎改善了传统物流仓储的种种难题。但现阶段 AGV 调度往往采用 WIFI 通信方式，存在着易干扰、切换和覆盖能力不足问题。4G 网络已经难以支撑智慧物流信息化建设，而 5G 具有大宽带特点，有利于参数估计，可以为高精度测距提供支持，实现精准定位。同时，利用 5G 网络延时低的特点，可以使得物流各个环境都能够更加快速、直观、准确的获取相关的数据，物流运输、商品装捡等数据能更为迅捷地达到用户端、管理端以及作业端。

Junye Pharm:
Empowering the High–Quality Development of Enterprises with Intelligent Manufacturing

Founded in 1998, Zhejiang Xianju Junye Pharmaceutical Co., Ltd. (hereinafter referred to as Junye Pharm) has always adhered to the principle of "building an eternal business with noble quality" to provide advanced steroid hormone intermediates, raw materials as well as innovative process R&D and large–scale production services (CDMO) to global pharmaceutical enterprises. At present, the CDMO platform is undertaking steroid drugs research, development and production by cooperating with more than 100 partners from nearly 20 countries around the world.

The pharmaceutical industry is an important part of China's economic growth, and it is also the key field for popularizing intelligent manufacturing. Traditional manufacturing still encounters many difficulties in the process of intelligent advancement as it involves multiple materials and processes and order–based manufacturing mode. Therefore, further explorations of the traditional industry are urgently needed to provide experiences and new models of intelligent manufacturing that can be replicated and promoted and thus lay a foundation for further innovation, application and promotion of intelligent manufacturing.

Accelerating digital transformation

Based on the new generation of information technology and advanced manufacturing technology, digitalization has been applied to the projects under construction throughout the whole production and operation process with the

The pharmaceutical industry is an important part of China's economic growth, and it is also the key field for popularizing intelligent manufacturing.

support of Internet interconnection. Through digital modeling of process flow and workshop layout, operation optimization and predictive diagnosis of process flow, high integrated online monitoring and diagnostic predictive evaluation system of output, quality and energy consumption, and intelligent MES highly integrated with ERP, Junye Pharm has realized the optimal control of the whole production process and supply chain, improved production efficiency, and reduced operating costs and product rejection rate.

1. Each reaction tank is controlled by DCS system to automatically adjust the temperature, replenish materials, and monitor the process parameters. The extraction system adopts automatic liquid level monitoring, and automatic feeding and separation. Automatic control is adopted in each process of refining, recovery and drying. Both of the numerical control rate and the automatic production data collection rate of key equipment have reached 70% , which is leading in the industry.

2. The use of advanced equipment has decreased the number of on-site feeding personnel and operators by 50% , and reduced the impact of human operation on production to improve production efficiency by 50%.

3. As the labor cost is greatly reduced and the production efficiency is improved, the automatic, continuous and closed operation can reduce solvent loss and improve the equipment utilization rate. In addition, with the extensive use of frequency converters, the high degree of synergy of each process as well as the precise control of each process parameter, energy saving and emission reduction can be achieved by 40%, and the cost is reduced by 40%.

5G+ Technology Empowers Future Factories

The future factory will be the integration of digital virtual and physical reality as well as ICT technology and modern manufacturing industry, so as to improve the flexibility, traceability, versatility and production efficiency of industrial production, which opens up a new business model for manufacturing industry.

Each reaction tank is controlled by DCS system to automatically adjust the temperature, replenish materials, and monitor the process parameters. The extraction system adopts automatic liquid level monitoring, and automatic feeding and separation.

1. Remote equipment operation and maintenance

In the future, every object in the factory will be a terminal with unique IP so that the raw materials in the production process will be "informatized". Raw materials will then be automatically produced and maintained according to the "information". People also become terminals with their own IP, and they will be a part of the whole production process with other industrial robots to exchange information with raw materials, equipment and products with unique IPs. While industrial robots manage factories, people who are thousands of miles away can receive real-time information and interact with each other.

2. Equipment networking

With the development of industrial Internet, more workshop equipment, such as machine tools, robots, AGV, etc., waits to access the factory intranet, especially the communication of mobile devices such as AGV, which makes it difficult for wired network alone to deal with the problem and thus requires the intranet and bandwidth to be more powerful and flexible. Traditional factory wired network has reliable bandwidth but poor flexibility, while wireless network has high flexibility, but insufficient reliability, coverage and access quantity. Having high flexibility, powerful bandwidth and multi-terminal access, 5G has become a new choice for equipment access and communication in factories.

3. Quality control

5G-supported bandwidth has low latency. By 5G+AI+ machine vision, micron-scale targets can be observed to obtain comprehensive and traceable information, and the relevant information can be easily integrated and retained to change the whole quality inspection process.

4. Visualization factory

5G technology can provide a full cloud network platform for intelligent factories. Precision sensing technology is used in sensors to report information status in a very short time. A large number of industrial data are collected through 5G network, and a huge database begins to form. Industrial robots combined with

cloud computing can learn independently and make accurate judgments with their supercomputing abilities to give the best solution and truly realize a visualized transparent factory.

5. Logistics management

With the application of RFID, EDI and other technologies, the development of intelligent logistics supply has almost solved various problems of traditional logistics warehousing. However, at present, AGV scheduling often adopts WIFI communication, which is vulnerable to interference and switch and has insufficient coverage. While it has become difficult for 4G network to support intelligent logistics information construction, 5G, with its wide bandwidth, is conducive to parameter estimation and can support high−precision ranging and achieve accurate positioning. At the same time, taking advantage of the low delay of 5G network, the related data can be obtained more quickly, intuitively and accurately in all logistics environments, and the data such as logistics transportation and commodity loading and picking can reach the user end, management end and operation end more quickly.

工交机械：持续改进 深入挖掘数据的价值

浙江工交机械股份有限公司（以下简称工交机械）是一家专业的汽车底盘零配件制造企业。公司成立于 1992 年，发展至今已有近三十年的历史。公司主要生产转向拉杆球销，控制臂球销等底盘类安全件，配套车型品牌包括奔驰、宝马、大众、通用、沃尔沃、特斯拉等国内外中高档汽车。

工交机械的数字化转型可以从外部动因和内部动因两个角度来溯源和阐释。外部动力在于公司的客户均为国际知名的世界五百强企业，对战略供应商有着精细化管理要求，要求供应商具有订单数据及时反馈的能力，而这一能力离不开企业信息系统的支持，同时汽配安全零件的质量要求非常高，必须要做到每一年零件从材料源头到成品的可追溯性，因此也对供应商的信息管理能力作出了要求。而数字化转型更重要的动力则是来自于公司高层对于自身业务能力提升的要求以及对精细化成本管理理念的贯彻与落实。

公司在 2017 年上线了 ERP 系统用以指导企业的订单生产和资源规划。ERP 系统核心是针对供应链、财务、物流和人力资源的企业上层管理，对于车间的生产制造管理存在盲区，从而出现了以下几个无法解决的痛点：

一是 ERP 下达的工单到生产现场后，无法对现场进行实时有效管控，生产数据时滞性严重，数据统计分析依靠人工，不及时不准确，各类报表繁杂；

二是仓库库存不准确，盘点工作量大，依靠人工实时库存更新不及时；

三是计件工资和成本核算不精确，且耗费大量人工；

四是现场大量纸质文件、记录易损难管；

五是刀具寿命不易在线管控，影响生产效率及质量分析；

六是设备产能足够，产量却低于预期，主要因为设备利用率低；

七是质量问题发生后，追溯难，责任不能到人；

八是质检工作未按规定间隔时间执行，投料错误、漏跳工序等质量事

件时有发生。

为了切实解决以上问题，工交机械成立了生产智能制造系统实施小组，实地调研了几家专业的系统制造商，最终结合企业实际选定了牡牛工业互联网（杭州）有限公司为工交机械定制开发的智能制造 GMES 系统来应对以上出现的痛点。

GMES 系统是面向车间现场管理的智能管理平台，包含基础设置、设备管理、工装管理、物料管理、安灯系统、制造模型、生产管理、质量管理、智能报表和作业文件管理等模块，通过强大的数据采集功能，实现了车间管理的监控、分析、预警和追溯等四大核心管理难点。

通过 GMES 系统的使用，车间生产管理从传统的"管人理事"转型至"基于数据"的管理方式，通过设备物联网和移动互联网技术，能够实时准确地获得生产过程中所需的各类数据，减少人力的同时又可以精准地推行精益生产改善，打造实现工业互联网数字化工厂，让数据驱动生产力。

（一）节约人工成本

GMES 系统可自动、准确地进行生产排程，同时协调设备、物料及工装，极大地提升了生产力。原生产线一名员工仅能管理两台设备，现可实现一人管理六台。仅精工车间生产一线员工就减少了 25 人。另外通过自主的报工和质量控制，相应的统计员、质检员减少 2~3 人。用工成本降低 50%。

（二）数据实时掌握

GMES 系统打破了以往 ERP 系统中企业生产制造的盲区，生产数据的反馈不再滞后。通过设备数据的采集、处理与展示，管理人员可以通过手机 APP、电子看板实时了解工单的生产执行情况。现场物料、设备、工装出现故障，可通过 GMES 安灯系统及时了解，并迅速做出调整，提高生产稳定性。

（三）降低库存

移动端扫码出入库便捷高效，库存信息实时更新，库存明细清晰准确易检索。在制品数量可查询，实时展示库存波动、安全库存预警，提升仓库利用率和库存周转率。通过系统的提升，原材料产品库存减少 35%。通

GMES 系统可自动、准确地进行生产排程，同时协调设备、物料及工装，极大地提升了生产力。原生产线一名员工仅能管理两台设备，现可实现一人管理六台。

过单件流的改造，缩短生产周期，车间在制品降低，现场整洁度也大幅提升。

（四）提高经济效益

通过智能制造系统的利用，生产设备 OEE 利用率提高，使产能提升约30%，产品质量不合格率降低约 15%，业务操作生产效率提升约 20%，整体生产交付周期缩短约 30%，在制品滞留数量下降约 40%，纸质文件记录报表减少约 70%，数据汇总分析时间缩短约 90%，综合经济效益大幅提升。

Gongjiao Machinery: Further explore the value of data with continuous efforts

Zhejiang Gongjiao Machinery Co., Ltd. (hereinafter referred to as Gongjiao Machinery) is a professional auto chassis parts manufacturing enterprise having a history of more than 30 years since its foundation in 1992. Its main products include all kinds of chassis parts, such as steering ball pin, control arm ball pin, etc. These products are widely used in auto steering device of famous auto brands, including Mercedes Benz, BMW, Volkswagen, GM, Volvo, Tesla and other high-end autos.

The digital transformation of Gongjiao Machinery is motivated by both external and internal factors. The external factor lies in the fact that the company's customers are global renowned Fortune 500 enterprise having refined management requirements for their strategic suppliers to give timely feedback of order data, which heavily depends on the support of the information system of the enterprise. At the same time, the demand of high-quality auto safety parts requires both the final products and the source of materials being traceable annually, which raises challenges to the information management ability of suppliers. The other internal driving force essential to the digital transformation of the company comes from the commitment of the top managers to improving their own business capabilities and the implementation of the concept of refined cost management.

In 2017, the company launched ERP system to guide the order production and resource planning of the company. The core of ERP system is the upper management of supply chain, finance, logistics and human resources, but it is incapable of managing the production and manufacturing of the workshop, which leads to the following unresolved problems:

First, after the work order issued by ERP arrives at the production site, it is

impossible to carry out real−time and effective management and control on the site, which causes serious time lag of production data. The statistical analysis depending on manpower is not timely and accurate, and will lead to various complicated reports;

Second, the warehouse inventory is inaccurate, the inventory workload is large, and the manual real−time inventory update is not timely;

Third, piecework wages and cost accounting are inaccurate and consume a lot of

Fourth, a large number of paper documents and records on site are vulnerable and difficult to manage;

Fifth, the tool life is hard to be controlled online, which affects production efficiency and quality analysis;

Sixth, though the equipment production capacity is sufficient, the output is lower than expected mainly because of the low utilization rate of equipment;

Seventh, it is difficult to call to account when quality problems occur;

Eighth, quality inspection is not carried out according to the specified time interval, and quality problems such as feeding errors and missing procedures occur from time to time.

In order to effectively solve the above problems, Gongjiao Machinery has set up a team for intelligent manufacturing system construction to investigate several professional system manufacturers on the spot, and finally selected the intelligent manufacturing GMES system customized and developed by Guniu Industrial Internet (Hangzhou) Co., Ltd. to deal with the above problems.

GMES system is an intelligent management platform for workshop site management, which includes fundamental setup, equipment management, tooling management, material management, lighting system, model manufacturing, production management, quality management, intelligent report and job file management, etc. Through powerful data collection functions, four core management difficulties including monitoring, analysis, early warning and

The statistical analysis depending on manpower is not timely and accurate, and will lead to various complicated reports.

traceability of workshop management are realized.

Through the use of GMES system, the workshop production management has been transformed from the traditional mode of "managing the labors while dealing with affairs" to the "data-based" management mode. Through Internet of Things and mobile Internet technology, all kinds of data needed in the production process can be obtained in real time and accurately, which can reduce manpower while promoting lean production, and build a digital factory to drive productivity by data.

(1) Save labor costs

GMES system can automatically and accurately schedule production, coordinate equipment, materials and tooling, and greatly improve productivity. One employee of the original production line can only manage two devices, but now can manage six. The number of front-line employees in Seiko workshop only decreased by 25. In addition, through independent reporting and quality control, the number of statisticians and quality inspectors is reduced by 2 to 3. The labor cost is reduced by 50%.

(2) Control data in real-time

GMES system has solved the problem of untimely feedback of production data of ERP system in enterprise manufacturing. Through the collection, processing and display of data from equipment, managers are able to know the execution of work orders in real time through mobile apps and electronic billboard. When materials, equipment and tooling troubles on site occur, it can be known in time through GMES lighting system, and adjustments can be made quickly to improve production stability.

(3) Reduce inventory

It is convenient and efficient to scan code in and out of the warehouse on the mobile terminal, the inventory information is updated in real time, and the inventory details are clear, accurate and easy to retrieve. The quantity of work-in-process can be queried, and inventory fluctuation and safety stock

Through the use of GMES system, the workshop production management has been transformed from the traditional mode of "managing the labors while dealing with affairs" to the "data-based" management mode.

warning can be displayed in real time, so as to improve warehouse utilization rate and inventory turnover rate. By upgrading the system, the inventory of raw materials and products was reduced by 35% . Through the transformation of one−piece flow, the production cycle is shortened, the work−in−process in the workshop is reduced, and the cleanliness of the site is greatly improved.

(4) Improve economic benefits

Through the use of intelligent manufacturing system, the OEE utilization rate of production equipment is improved, from which the production capacity is increased by about 30%, the unqualified rate of products is reduced by about 15%, the production efficiency of business operation is increased by about 20% , the overall production delivery cycle is shortened by about 30%, the detention quantity of work−in−process is reduced by about 40% , the paper document records and reports are reduced by about 70% , the time of data summary and analysis is shortened by about 90% , and the comprehensive economic benefits are greatly improved.

新天力:发挥IT价值 提升企业核心竞争力

浙江新天力容器科技有限公司（以下简称新天力）成立于 1990 年，是一家集一次性纸塑食品容器研发设计、生产、销售于一体的集团公司。

在企业发展过程中，如何发挥好信息化的护航作用，帮助企业不断进行产品迭代与提供一站式解决方案的服务理念升级，从而最终提升企业竞争力，这是新天力多年来一直思考和深入探讨的问题。

信息化是企业的灯塔

新天力 CEO 何麟君表示："公司有 3 条赛道，一条是业务赛道，一条是人才赛道，一条是信息化赛道。从信息化建设的角度说，人才是基石，信息化是护航的灯塔，业务是最终的价值体现。"

近几年来，新天力自上而下，从高层到中层再到基层，全员高度认同信息化建设的重要性并对数字化转型达成共识。通过对标行业优秀企业，寻找自身差距，从整个结构治理，到标准化执行的落地，再到系统的统筹考量和考虑，都做了总体的规划。

新天力通过自上而下层层分解，自下而上层层保证，信息化各项工程稳步推进，先后完成以 ERP 系统、CRM 系统、电子合同管理为主的企业制造和管理信息化建设；以监控系统、办公智能化为主的企业管理和安全信息系统建设；以 MES、仓储扫码系统为主的智能化生产执行系统建设；同时不断优化和完善信息化安全管理制度建设。

企业制造和管理信息化建设：通过外购软件定制化开发及现有部分管理软件更新升级换代，形成符合企业塑料制品制造业特色的，与自身国家级高新技术企业研发需要和行业龙头企业相适应的管理信息系统，实现研发、生产、库存、物流、内销、国贸、财务、人力资源系统一管理。

企业管理和安全信息系统建设：全厂部署监控系统、办公区域智能化及车间广播系统，设有信息化机房、接入双核心光交及深信服超融合

aCloud 及网康（互联网控制网关）等硬件设备

　　智能化生产执行系统（MES）建设：通过本项目的实施，新天力建立了一套标准的塑料制品生产管理体系来管理整个生产系统的业务，实现生产的透明化管理、实时的生产数据统计、精准的库存物料管理、精准的计划排程。

　　仓储扫码作业智能化建设：正在进行的"仓储扫码作业智能化建设项目"将于 2021 年 6 月完工。通过 PDA 扫描板架 / 物资上的二维码，实时记录物资的出入库数据，自动生成出入库报表。用户进入系统，可查看物资从入库到出库所有的流转情况。使仓储管理更加精细化，有效解决库存位置混乱、仓储效率不高、人员依赖过大等原料库管理难题。

　　企业信息安全管理制度：公司为加强计算机系统、办公网络、服务器的管理，保障网络和数据库系统安全运行，提高计算机办公人员的安全意识，保证保护企业的信息安全，制定了《信息系统安全保密与泄密责任追究制度》（2020 年 1 月 9 日审核通过并即日施行）。

信息化提速　企业技术中心共享企业信息系统

　　新天力的信息化建设，离不开两个提速：

　　一是全员意识提速，从前期的懵懵懂懂到中期的理解了解，再到目前的高度重视，新天力将信息化建设上升到与公司战略同等的高度。通过各种会议进行全员宣贯，达到思想统一、上下同欲、全员参与。

　　二是资源投入加大。抽调和选聘专业的信息化人员组建队伍、公司内优秀资源优先倾斜、设备采购优先审批。

　　目前信息化建设已经很好地服务于销售系统、生产系统、供应链系统，信息化系统初见成效。在未来，新天力将着力打造一个信息流，将各项信息化工程有效的串联，形成一个统一的整体。企业技术中心所需要的产品设计信息、数据、构图，由技术中心的计算机辅助设计软件（UG 软件）来实现。ERP 系统提供生产成本、BOM 信息，MES 提供有效的产业化量产安排和数据反馈，专门的办公协同系统提供了产能、仓存与订单的有效衔接和客户订单信息的传递。

新天力建立了一套标准的塑料制品生产管理体系来管理整个生产系统的业务，实现生产的透明化管理、实时的生产数据统计、精准的库存物料管理、精准的计划排程。

Xintianli:
Fully Unleash the Value of IT to Promote the Core Competitiveness of Enterprises

Zhejiang Xintian plastic container Co., Ltd. (hereinafter referred to as Xintianli), established in 1990, is a group company integrating R&D, design, production and sales of disposable paper and plastic food containers.

In the process of development, Xintianli has never stopped thinking how to give full play to the escort role of informatization to help enterprises continuously carry out product iteration and upgrade the service concept of providing one−stop solutions to finally enhance the competitiveness of enterprises.

Informatization lights the way for enterprises

He Linjun, CEO of Xintianli, said: "The company has three tracks, the business track, the talents track and the information track. From the perspective of information construction, talents are the cornerstone, informatization is the lighthouse, and business is the ultimate embodiment of value."

In recent years, employees of Xintianli at all levels highly admits the importance of information construction and reach a consensus on digital transformation. By comparing with and learning from the outstanding enterprises in the industry, Xintianli has made overall plans from the whole structural governance to the implementation of standardization, and then to the systematic considerations.

Through top−down divisions and bottom−up assurances, Xintianli has steadily advanced various informatization projects including the construction of enterprise manufacturing and management informatization focusing on ERP

In recent years, employees of Xintianli at all levels highly admits the importance of information construction and reach a consensus on digital transformation.

system, CRM system and electronic contract management, enterprise management and information security system based on monitoring system and office intelligence, and intelligent production execution system based on MES system and warehouse scan code system. At the same time, information security management system has been constantly optimized.

Enterprise manufacturing and management informatization construction: Through customized development of purchased software and upgrading of some existing management software, an information management system conforming to the characteristics of plastic products manufacturing industry of the company and adapting to the R&D needs of national high−tech enterprises and leading enterprises in the industry is formed to achieve systematic management of R&D, production, inventory, logistics, domestic sales, international trade, finance and human resources.

Enterprise management and information security system construction: The monitoring system, intelligent office area and workshop broadcasting system are deployed in the whole factory, and informatized computer rooms equipped with dual−core light container delivery, hyper−converged aCloud by Sangfor and Net−com (Internet Control Gateway) and other hardware equipment are put into use.

Intelligent Manufacturing Execution System (MES) construction: Through the implementation of this project, Xintianli has established a set of standard plastic products production management system to manage the business of the whole production system, realizing transparent production management, real−time production data collecting and analyzing, accurate inventory material management and scheduling.

Intelligent construction of warehouse code scanning operation: The ongoing intelligent construction project of warehouse code scanning operation will be completed in June 2021. By scanning the two−dimensional code on the rack/material by PDA, the data of materials in−and−out will be recorded in real time and a report will be automatically generated. Users can enter the system and view all the

MES system provides effective industrial mass production arrangement and data feedback, and special office collaboration system provides effective connection among production capacity, warehouse storage and orders and transmission of customer order information.

circulation information of materials from warehousing to outbound, which makes the warehouse management more refined, and effectively solves the problems of raw material warehouse management, such as chaotic inventory location, low stor－age efficiency, excessive dependence on personnel, etc.

Enterprise information security management system: In order to strengthen the management of computer systems, office networks and servers, ensure the safe operation of network and database systems, improve the safety awareness of com－puter office workers, and ensure the security of enterprise information, the company has formulated the Accountability Regulations of Information System Security and Disclosure (which was approved and implemented on January 9, 2020).

Accelerate informatization to share enterprise information system with enterprise technology centers

The informatization of Xintianli depends on two positive measures:

First, the awareness of all employees has been improved. Xintianli has regarded informatization as the company＇s strategic measure by continuously improving the awareness of staffs. By holding various meetings, all staffs have fully realized the importance of informatization and actively participated in information construction.

Second, investment for informatization has increased by selecting professional personnel to form a group, putting more resources to informatization and giving priority to equipment procurement approval.

At present, the fruit of information construction has been used in the sales system, production system and supply chain system, and the information system has achieved initial success. In the future, Xintianli will strive to creating an information flow by effectively connecting various information projects to form a unified entity. Product design information, data and composition required by enterprise technology center are realized by computer aided design software (UG

software) of technology center. ERP system provides production cost and BOM information, MES system provides effective industrial mass production arrangement and data feedback, and special office collaboration system provides effective connection among production capacity, warehouse storage and orders and transmission of customer order information.

永高股份：精益体系下的数字化工厂建设

　　永高股份有限公司（以下简称永高股份），成立于 1993 年 3 月，是一家产业涉及塑料管道、光伏太阳能、家用电器开关插座、智能装备和贸易等多个领域的大型集团。公司现下辖十四家全资子公司和三家参股公司，主业现有市政管网、工业管网、建筑工程、消防保护、电力通信、全屋家装、农业养殖、燃气管网等 8 大系统的产品。

　　近年来，公司累计投入 6.5 亿元，以工业机器人、智能制造、物联网技术等为突破口，深入推进信息技术在制造业生产各环节的应用，提高装备智能化率，实现生产过程自动化、数字化，公司单位产品人工成本能降低 50% 以上，人均产出提升 30% 以上。

　　随着我国改革开放的不断深入和国家对基础设施建设投入的不断加大，近年来塑料管道行业得到了迅猛的发展。在市政及建筑给排水、农用（饮用水和灌排）、市政排污、燃气、供暖、城市非开挖施工、工业、通信、电力、矿山等领域，塑料管道发挥着越来越重要的作用。不过，在行业快速发展的同时，也存在一些不足和问题，行业制造自动化程度低、生产人员阶段性用工需求不足、人员工资报酬不断增加等给公司经营带来很大压力。为此，永高股份从运营管理、数字化车间、智能指挥中心等方面进行了积极探索，并取得了显著成果。

随着我国改革开放的不断深入和国家对基础设施建设投入的不断加大，近年来塑料管道行业得到了迅猛的发展。

（1）YES 卓越系统

　　永高在精益管理的基础上，融合创造出公司独特有效的管理方法，YES 卓越系统管理模式。YES 卓越系统是以"人人 YES，事事卓越"为理念，以"精益制造、持续创新、价值共享"为方针、以高质量产品、高产出收益、高素养人才的"三高"和业务流程化、装备自动化、现场精细化、工艺标准化、信息系统化的"五化"为具体目标，以计划物控、精益现场、工程技术为主要载体，最终体现卓越现场、卓越改善、卓越课题、卓越安

全、卓越设备、卓越项目和卓越绩效。

(2) 数字化车间建设

采用物联网技术，购置全自动混配系统、新型节能注塑机、高速挤出线、自动化包装线、工业机器人等设备，提升车间自动化、数字化水平。

将自动化改造后的设备进行物联，利用业务终端，采集设备状态信息，将生产现场的所有物体感知并相连，实现互通，使生产计划指令下发到机台、实时采集生产数据（人、产品、设备、质量等），并实时上报，形成各种应用的数据和信息，使车间管理人员、支持和协作人员、高层主管以数据为决策依据，积极、快速响应，通过系统分析软件对各种生产数据进行分析，确定责任，提高管理决策速度和准确性，精确进行生产改进。

(3) 智能指挥中心建设

以数字化、网络化、可视化为手段，实现生产智能排程、生产进度实时跟踪、生产场景视频监控、生产指令实时下达等功能，将生产情况和现场状态集中显示，整体调度，建设三位一体生产指挥中心。

为满足生产状态集中显示与指挥，生产指挥系统包含以下 4 个子系统：集中显示系统、制造物联系统、视频监控系统、实时对讲系统。

集中显示系统：集中显示生产现场的视频信息、设备状态信息、生产进度等实时信息，并具备数据信息联动功能，实现生产指令的远程下发和调度。

制造物联系统：通过设备终端，实时收集设备运行信息、生产进度等实时数据，监控工厂人机料、水电气、生产进度、工艺参数和质量等生产要素，实现智能化管理。

视频监控系统：通过摄像机等前端设备，将车间、装卸区、仓库等区域现场图像传输至指挥中心，并实现视频数据的存储和事后检索查看。

实时对讲系统：通过对讲机等设备实现生产指令和任务的实时下发，实时高效语音通话，方便相关部门的统一指挥和调度。

（4）项目建设取得成效

通过本项目实施，实现实时监控和预报警、自动采集生产原始数据使企业快速决策，提高管理效率，大幅度降低生产成本。通过实时对设备利用率的提升，以及生产总效率的提升，使生产计划的安排更合理，减少了等待时间实现了公司行为节能。生产数据自动采集和发送，取消了人工统计，减少了辅助人员用工，提高了管理效率，降低了企业的人力成本和用工压力。

同时，通过本项目实施，关键设备智能化率达到 85%以上，制造过程的数控化度达到 90%以上，实现运营成本降低 30％，产品生产周期缩短 30％，不良品率降低 30％的目标；减少人员 60%以上。

Yonggao Co. Ltd.: Digital Factory Construction under Lean System

Yonggao Co. Ltd. (hereinafter referred to as Yonggao), founded in March 1993, is a large group with businesses involving plastic pipes, photovoltaic solar energy, household electrical switches and sockets, intelligent equipment and trade. The company now has fourteen wholly−owned subsidiaries and three share−holding companies, and its main business now consists of eight major types of products, including municipal pipeline network, industrial pipeline network, construction engineering, fire protection, electric power communication, house decoration, agricultural farming and gas pipeline network.

In recent years, the company has invested a total of 650 million yuan in industrial robots, intelligent manufacturing, and Internet of Things technology to further promote the application of information technology in all aspects of manufacturing production. Having improved the intelligence rate of equipment and achieved automation and digitalization of the production process, the company's unit product labor costs have been reduced by more than 50% and per capita output increased by more than 30%.

With the deepening of China's reform and opening up and the increasing national investment in infrastructure construction, the plastic pipeline industry has been developing rapidly in recent years. In the municipal and building water supply and drainage, agricultural (drinking water and irrigation and drainage), municipal sewage, gas, heating, urban non−excavation construction, industry, communications, electricity, mining and other fields, plastic pipes play an increasingly important role. However, while the industry is developing rapidly, there are also some shortcomings and problems. The low level of manufacturing automation in the industry, the insufficient demand for labor in production personnel stage, and the in−

In recent years, the company has invested a total of 650 million yuan in industrial robots, intelligent manufacturing, and Internet of Things technology to further promote the application of information technology in all aspects of manufacturing production.

creasing salary and compensation of personnel have put great pressure on the com-pany's operation. For this reason, Yonggao has been actively exploring operation management, digital workshop and intelligent command center, and has achieved remarkable results.

（1）YES Excellence System

Based on lean management, Yonggao has created a unique and effective management method, the YES Excellence System management model. With "lean manufacturing, continuous innovation, value sharing" as the key policy, "high quality products, high output and high quality talents" and "business process, equipment automation, site refinement, process standardization and information system" as the objectives, the system is based on planning and material control, lean site, standardization and information system. With planning and control, lean manufacturing, engineering technology as main drivers, it aims to seek excellence in site, projects, safety, equipment, and performance.

（2）Digital workshop construction

The company used IOT technology and purchased equipment like automatic mixing system, new energy-saving injection molding machine, high-speed extrusion line, automatic packaging line and industrial robots to make the workshop more automated and digital.

Based on IoT, the automated equipment is then connected with all business terminals at site to monitor equipment status and achieve interoperability, so that production planning instructions can be sent down to the machines while collecting production data (people, products, equipment, quality, etc.) and reporting them in real time. The data and information collected from various applications help workshop managers and senior executives to make data-based decisions and quick responses. By analyzing production data through the system analysis software, the responsibilities can be better defined to improve decision

With planning and control, lean manufacturing, engineering technology as main drivers, it aims to seek excellence in site, projects, safety, equipment, and performance.

making efficiency and accuracy and achieve precise production improvement.

（3） Intelligent command center construction

By means of digitalization, Internet and visualization, it has realized intelligent production scheduling, real-time tracking of production progress, video monitoring of production scenes and real-time distribution of production orders. Besides, by displaying the situations of production and factory in one platform and making overall scheduling, it has built a three-in-one production command center.

To enable the centralized display and command of production status, the production command system contains the following four subsystems: centralized display system, manufacturing IOT system, video monitoring system, and real-time intercom system.

Centralized display system: Centralized display of video information, equipment status information, production progress and other real-time information of the production site. Equipped with connective function of data information, it can achieve remote distribution and scheduling of production instructions.

Manufacturing IOT system: Through equipment terminals, real-time data such as equipment operation information and production progress are collected in real time, and production elements such as factory man, machine and material, water, electricity and gas, production progress, process parameters and quality are monitored to achieve intelligent management.

Video monitoring system: Through the front-end equipment such as cameras, the on-site images of workshops, loading and unloading areas, warehouses and other areas are transmitted to the command center. Moreover, the storage and post-event retrieval of video data have been made possible.

Real-time intercom system: Realize real-time distribution of production instructions and tasks through intercom and other equipment. Real-time and

efficient voice calls can facilitate unified command and arrangement of relevant departments.

（4） Achievements of project construction

After this project took effect, real−time monitoring and pre−alerting and automatic collection of production raw data were achieved, which helped the company to make quick decisions, improve management efficiency, and significantly reduce production costs. By improving the utilization rate of equipment in real time and the total efficiency of production, it makes the arrangement of production plan more reasonable, reduces the waste of waiting time, and helps saving energy in corporate actions. As production data is automatically collected and sent, there is no longer any need for extra human resource input, thus improving management efficiency and reducing the company's labor costs and pressure.

At the same time, the intelligence rate of key equipment reached more than 85% . More than 90% of the manufacturing process is completed by numerical control　and the operating costs were reduced by 30% , shortening the product production cycle by 30% , reducing the defective rate by 30% and reducing personnel by more than 60% .

水晶光电：以数字化转型助力产业升级

浙江水晶光电科技股份有限公司（以下简称"水晶光电"）创建于 2002 年 8 月 2 日，2008 年在深圳交易所挂牌上市。公司在光学领域建立起了以精密光学制造技术为核心、具有自主知识产权的技术体系，其中 3D 光学元器件、半导体光学元器件、AR 增强显示光学模块、微纳结构加工光学元器件等关键核心技术产品已量产并应用于全球知名消费电子、汽车电子、安防监控、工业应用企业的产品与服务中。

数字化转型的现状

水晶光电的数字化转型在 2018 年下半年开始拉开序幕，历经两年时间的推进落地，核心 ERP、生产管理部分基本实现数字化运营管理，转型回顾总结如下：

1.总体规划：对企业的信息化现状进行了梳理，结合基础架构管理的薄弱项、应用系统建设薄弱项提出了信息化的整体架构规划，包括基础服务器、工厂控制层、应用服务层、数据显示层、管理推进层等，整体架构落地围绕"统一化、重点突破、分步实施"展开。

2.落地实施：基础服务层以统一软件、统一网络、统一硬件、统一弱电、统一流程开展规范化落地；工厂控制层以统一规格、统一数据接口、统一自动化实施落地；应用服务器以统一规划、统一平台、统一数据、统一权限实施落地；数据显示层以统一语言、统一指标、统一考核实施落地；管理推进层以统一战略、统一方向、事件闭环实施地。数字化落地计划三年时间实现 MES、ERP、人力、5G 应用等覆盖各事业群，基本达成全面数字化管理。

3.项目工作

a.ERP 管理精益化：(1) 推进成本优化工作，落地日清日结，月结需要 10 多天压缩到 3 个工作日完成；①BOM 管理优化，从 8、9 阶全部优化到

水晶光电的数字化转型在 2018 年下半年开始拉开序幕，历经两年时间的推进落地，核心 ERP、生产管理部分基本实现数字化运营管理。

4 阶以内；②仓库、库位并合优化，缩减 2/3，配合 WMS 提升了现场操作效率；(2) 物料清洗，从 3 万多个物料缩减到 3000 多个，加强了物料的通用性提升；（3）按单发料，提升现场物料规范管理及 BOM 的精确性；(4) 按单采购，产供平衡，今年计划开展。

b.生产管理数字化：整合了 5 个版本的 MES（外购、自建、ERP），实现了各事业群平台的统一。（1）规范了生产计划的执行，从计划、工单、领料等环节实现按生产节拍备料、发料管理；（2）生产过程实现帐动、物动即时报工，从事后做账变成实时做账，生产过程投入、产出、良率、在制堆积、结卡率等实时性、透明性得到加强；（3）检查机数据实现实时采集，监控 SPC 等指标，提升工艺改善能力；（4）设备的计划、点检、保养等落地，实现无纸化管理，执行率得到提升；（5）仓库物料管理实现条码化管理，先进先出、质量时间等得到有效管理，杜绝了现场无序操作和事后做账。

c.研发管理：建立 IPD 管理流程，从研究院逐步推广到各事业群，计划 IPD 流程发挥整体运行效果时导入 PLM 进行管理。

d.人力管理：结合实际管理需求和线下管理问题，确定各项开展工作，诸如组织、岗位、招聘、考勤、薪资等信息化落地。

e.工业设计：公司引进了 autocad、UVprobe、SolidWorks 等工业应用设计软件，对产品、光学有限元分析等提供支持，辅助产品设计和工艺落地。

f.数据安全：引进 Ipguard、云桌面、Symantec 等保护企业的数字资产，在安全、防毒、研发等方面得到加强。

企业数字转型的难点、痛点及意愿

1.难点：（1）人的问题：从粗放式的管理到精益化、数字化的管理，迈出的步伐太大，对齐人的思路是难点，需要花大量时间传递行业经验和知识，成熟时间较长。

（2）事的问题：流程不畅，管理数字化是协同性、有机的整体，从线下搬到线上，需要对正常流程、异常流程建立规范和培训等，在落地时培训力度不够，或者认知不到位，对数字化转型也会有较大影响。

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（3）物的问题：设备、厂房布局等问题，厂建期做好事前规划、中远期战略规划非常重要，这块成为短板时，再来加强和调整，对数字化转型也会有大的影响。

2.痛点：（1）物料问题：原物料多、替代性差、采购成本高；账物不一致，生产完才做账，事后补账；物料月底月结才清理一次，库存存量等过多。

（2）数据无量化、不标准、不透明：数据无规范、滞后呈现，生产多少、产能多少、品质情况等不透明，需要估摸着决策

（3）流程不规范：报废品管理、研发品管理、工程变更管理等管理数字化不足，精益成本分析欠佳。

3.意愿：短期多对业务单位沟通交流，引导信息化思路，介绍业界最佳实践，改善短板加强内控管理能力建设，为信息化的平铺、深化应用奠定基础。

Crystal Optech: Promoting Industry Upgrade through Digital Transformation

Zhejiang Crystal Optoelectronics Technology Co.Ltd.(hereinafter referred to as "Crystal Optech") was founded on August 2, 2002 and listed on the Shenzhen Stock Exchange in 2008. The company has established a technology system in the field of optics with precision optical manufacturing technology as the core and enjoying independent intellectual property rights. Its 3D optical components, semiconductor optical components, AR augmented display optical modules, micro and nano structured processing optical components and other key core technology products have been mass produced and used in the products and services of world-famous consumer electronics, automotive electronics, security monitoring, and industrial applications.

The status quo of digital transformation

The digital transformation of Crystal Optech kicked off in the second half of 2018 and was achieved two years after. Digital operation management of core ERP and production management was basically realized. The process can be illustrated as follows.

1. Overall planning: after reviewing the current situation of informatization of the company, the overall architecture planning of information technology is proposed on the basis of the weaknesses in infrastructure management and application system construction, including basic server, factory control, application service, data display, management promotion, etc.. The implementation of the overall architecture is "unified, step-by-step, and clearly-focused".

2. Implementation: In terms of basic service, the software, network, hardware, weak electricity and processes will be unified to achieve informatization;

In plant control, the specifications, data interface, and automation will be unified; In application server, the planning, platform, data, and authority will be included as one; In data display, the language, indicators, and assessment will be based on unified standards; The management will make sure that the strategy corresponds with the direction. The digitalization implementation plan aims to make MES, ERP, human resources and 5G applications available in all business groups in three years, thus basically achieving comprehensive digital management.

3. What was done in the projects

a. Lean management of ERP: (1) Promote cost optimization, implement same−day accounting, and shorten the duration of monthly clearing form more than 10 days to 3 working days. ①BOM management optimization from level 8 and 9 to below level 4; ②Optimization of warehouse and storage space, reducing space by 2/3 and improving the efficiency of field operations with WMS. (2) Material for cleaning, reduced from more than 30,000 to about 3,000, enhancing the versatility of materials; (3) Giving materials by order to improve the standardized management of materials and the accuracy of the BOM on site; (4) Purchase by order to achieve the balance between production and supply, which is to be implemented this year.

b. Production management digitalization: It has integrated 5 versions of MES (outsourced, self−built, ERP) and unified the platforms of each business group. (1) Standardized the implementation process of production plans and made material preparation and issuance according to production schedule, including in process of planning, work orders, and material collection; (2) During the production process, any changes in the book or materials shall be reported to the factory, with accounting being made in real time. Indicators like input, output, yield rate, in−process accumulation and stuck rate shall be made more transparent and updated. (3) Real−time data collection from inspection machines to monitor SPC and enhance process improvement capabilities; (4) Paperless management of equipment planning, check and maintenance, thus improving execution rate; (5)

The digitalization implementation plan aims to make MES, ERP, human resources and 5G applications available in all business groups in three years, thus basically achieving comprehensive digital management.

Barcode management has been achieved in warehouse material management. Besides, efficient management of FIFO and quality time were realized, eliminating disorderly operation on site and delayed book−keeping.

c. R&D management: Establish IPD management process and gradually extend it to each business group, with the research institute as a starting point. When the IPD process plays its role in overall operation, PLM will be introduced to facilitate management.

d. Human resource management: Combined with the actual management demands and offline management problems, it will identify the informatization work required in areas such as organization, job posting, recruitment, attendance and payroll.

e. Industrial design: The company has introduced industrial application design software such as autocad, UVprobe and SolidWorks to provide support for product and optical finite element analysis and assist in product design and process implementation.

f. Data security: It introduced ipguard, cloud desktop, and symantec to protect its digital assets and strengthened security, virus prevention and R&D.

Difficulties, pain points and determination of enterprise digital transformation

1.Difficulties: (1) People: As the company takes a big step from crude management to lean and digital management, how to change people's ideas becomes an obstacle. A lot of time will be needed to transfer industry experience and knowledge.

(2) Work: Management digitalization is a synergistic and organic whole. Moving from offline to online, we need to establish norms and provide training for normal and abnormal processes. Insufficient training and awareness may affect the progress in digital transformation.

(3) Equipment: Medium and long−term strategic planning before the plant is

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built is essential. Strengthening and adjusting the equipment and plant layout when problems arise may also affect the digital transformation.

2. Pain points: (1) Materials: There are too many kinds of raw materials, with poor substitutability and high procurement costs. The materials used are not recorded in accounting in time. Materials are cleaned up only once at the end of the month, leaving too much stock.

(2) Lack of quantitative data, standardization and transparency: the data lacks specifications and is presented with a lag. The decision-making is not well-supported by data of production, capacity, and quality.

(3) Unstandardized processes: Insufficient digitalization of management of end-of-life products, R&D products and engineering change and poor lean cost analysis.

3. Determination: In the short term, it will communicate more frequently with major departments and introduce best practices of the industry. Meanwhile, it will improve its weaknesses and strength internal control and management, paving the way for deeper and broader application of informatization results.

正特股份：
打造数字化工厂 推动行业新发展

浙江正特股份有限公司（以下简称正特股份）是一家集户外休闲家具及用品研发、生产、销售、服务于一体的高新技术企业。公司创建于 1996 年，经过二十多年的不懈努力，已建立起以铝、钢、再生塑料为主要原料的完整、领先的户外休闲行业制造体系，产品主要包括户外家具、户外遮阳、救灾帐篷等系列。

打造未来工厂 实现数字化转型

经过 20 多年的发展，正特股份与全球各大门户渠道的头部客户建立了长期稳定的合作关系。然而，随着跨境电商的发展、行业资源整合的加剧，市场的不确定性正在增加，正特需要提升核心竞争力，增强客户的信任度。2018 年，正特股份与深圳百思特展开战略咨询合作，正式开启正特二次创业新征程，以"百年正特、世界品牌、享誉全球的休闲用品提供商"为愿景，围绕"制造为本、研发引领、大户优先"的发展战略，启动数字化转型，打造更强的核心竞争力——数字化工厂。

正特数字化工厂基于计算机技术和网络技术的发展，通过信息化智能化的创新升级，将 ERP、APS、MES、PLM 及 SRM 等信息系统渐进地植入生产体系中，并从原材料的性能分析开始，将信息基因辐射至产业链后端。按照精益生产原理，对生产制造端的管理方式、技术措施、设施规划的重新布局，积极应用计算机信息与智能化技术，提升生产制造水平。

生产系统采用先进数控加工生产线，实现生产的数字化；通过数据采集与分析系统、制造执行系统（MES）、企业资源计划系统（ERP）、产品生命周期管理系统 (PLM)、供应商协同管理系统（SRM）及信息互联互通，建立企业级统一大数据平台，完善工厂工业化和信息化体系，实现了生产数据的实时采集，生产可视化管理、质量管理分析、设备管理、物料信息

管理等功能，最终打造一个高度柔性、质量可靠、响应敏捷、成本可控的数字化工厂。

"数字化工厂"带来的新变化

新一代信息技术应用：5G+AI 检测 +AGV 智能调度技术的应用。基于 5G 网络，结合 AI 检测技术，调度系统实现 AGV 的地图模型建立、多路径最优规划、多任务负载均衡以及多 AGV 交通动态调度管理。

数字化设计：通过设计及研发工具数字化及内外部相关方协同，销售、工艺、质量、生产主动介入设计及研发过程，提高研发效率和质量，加快产品产出。基于设计及研发工具数字化应用，实现研发项目透明可视，对研发项目资源合理有效利用，实现研发项目的质量、进度可控，打造研发过程闭环管理。

智能化生产：通过企业资源计划系统（ERP）、高级计划排程（APS）、制造执行系统（MES）等信息化系统，实现生产制造全面自感知、自优化、自决策、自执行，实现生产设备、产线、车间及工厂智能运行，提高生产计划准确性和生产过程的可控性。

数字化管理：通过 PLM 对产品的整个生命周期进行全面管理实现企业数据资源的分类管理、达到产品开发流程的规范化管理，最终实现跨部门（人、财、物、产、供、销）的产品信息传递，帮助企业经营管理与决策的核心，结合 OA、SCM、HR 等系统整合企业信息流、工作流、物流等，实现企业数字监控、数字管理、以及数字决策。

网络化协同：建立公司内部通信网络架构，实现设计、工艺、制造、检验、物流等制造过程各环节之间，以及制造执行系统（MES）、企业资源计划系统（ERP）、产品生命周期管理系统（PLM）等关键信息化管理系统之间的信息互联互通与集成。

绿色化生产：建立能源综合管理监测系统和产耗预测模型，实现能源资源的优化调度、平衡预测和节能管理；建立环保监测系统，实现从清洁生产到末端治理的全过程环保数据采集、实时监控及报警，开展可视化分析。

新一代信息技术应用：5G+AI 检测 +AGV 智能调度技术的应用。基于 5G 网络，结合 AI 检测技术，调度系统实现 AGV 的地图模型建立、多路径最优规划、多任务负载均衡以及多 AGV 交通动态调度管理。

安全化管控：利用大数据技术，对安全进行预警，实现生产过程中人员、物料、过程、设备、环境、信息等六类安全风险要素的智能化管控。使用自主可控的软件、系统和设备，开展功能安全与网络信息安全一体化协同防控，实现网络化智能化工业应用的综合安全保障。

Zhengte:
Building a Digital Factory to Promote the New Development of the Industry

Zhejiang Zhengte Co. Ltd. (hereinafter referred to as Zhengte) is a high-tech enterprise that integrates research and development, production, sales and service of outdoor leisure furniture and supplies. Founded in 1996, after more than twenty years of efforts, the company has established a complete and leading manufacturing system in the outdoor leisure industry with aluminum, steel and recycled plastic as the main raw materials, and its products mainly include outdoor furniture, outdoor shade, disaster relief tents and others.

Building the factory of the future to achieve digital transformation

After more than 20 years of development, Zhengte has established long-term and stable relationships with big customers of major global portal channels. However, with the development of cross-border e-commerce and the intensified integration in industry resources, market uncertainty is increasing. Zhengte needs to improve its core competitiveness and enhance customer trust. In 2018, Zhengte and Shenzhen Best started to cooperate in strategic consulting, which represents the beginning of a new adventure for Zhengte. Adhering to the vision of "100-year old Zhengte and world-famous provider of leisure products" and the development strategy of "manufacturing-based, R&D-led, and large clients first", it started the digital transformation to build stronger core competitiveness – digital factory.

Based on the development of computer technology and Internet technology, the digital factory of Zhengte has gradually implanted information systems such as

ERP, APS, MES, PLM and SRM into the production system through the innovative upgrading of information technology and intelligence. Starting from the performance analysis of raw materials, the information gene was also embedded in the back end of the industrial chain. According to the principle of lean production, the management methods, technical measures and facilities planning of the manufacturing end were rearranged, and computer information and intelligent technologies were actively applied to improve its production and manufacturing.

CNC processing lines were adopted in the production system to realize the digitization of production; through data collection and analysis system, manufac-turing execution system (MES), enterprise resource planning system (ERP), prod-uct lifecycle management system (PLM), supplier collaboration management system (SRM) and information interconnection, a unified enterprise-level big data plat-form is established to improve the factory industrialization and information system. The functions include real-time collection of production data, production visual-ization management, quality management analysis, equipment management and material information management, which aims to create a highly flexible, reliable, responsive and cost-efficient digital factory.

New changes brought about by "digital factory"

New generation information technology application: 5G + AI detection + application of AGV intelligent scheduling technology. Based on 5G network and AI detection technology, map model building of AGVs, multi-path optimal planning, multi-task load balancing and dynamic scheduling management of multi-AGV traffic have been realized in the scheduling system.

Digital design: Through the digitalization of design and R&D tools and the collaboration of internal and external parties, sales, processing, quality and production processes are connected with the design and R&D process to improve R&D efficiency and quality and accelerate product output. Based on the digital application of design and R&D tools, the results of R&D projects are made more

transparent. Effective utilization of R&D project resources has also improved quality control and progress monitoring of R&D projects, thus ensuring closed-loop management of the R&D process.

Intelligent production: Through the enterprise resource planning system (ERP), advanced planning and scheduling (APS), manufacturing execution system (MES) and other information systems, the company realized comprehensive self-awareness, self-optimization, self-decision and self-execution in manufacturing as well as intelligent operation of production equipment, production lines, workshops and factories. Besides, the production planning has been made more accurate and the production process more controllable.

Digital management: Through PLM, management of the entire product lifecycle is enabled to achieve the classification of enterprise data resources and standardized management of product development process.

Digital management: Through PLM, management of the entire product lifecycle is enabled to achieve the classification of enterprise data resources and standardized management of product development process. Moreover, it can help realizing the transfer of product information across departments (human resources, finance, material, production, supply and sales) to help business decision making. Enterprise information flow, work flow and logistics are also integrated through OA, SCM, HR and other systems, so as to realize enterprise digital monitoring, digital management and digital decision making.

Network synergy: Internal communication network architecture was established to realize the interconnection and integration of information among various elements of the manufacturing process such as design, process, manufacturing, inspection and logistics, as well as key information management systems such as manufacturing execution system (MES), enterprise resource planning system (ERP) and product life cycle management system (PLM).

Green production: An integrated energy management and monitoring system and production and consumption prediction model have been established to achieve optimal scheduling of energy resources, balance prediction and energy-saving management; an environmental protection monitoring system has also been put in place to enable environmental data collection, real-time

monitoring and alarming, which covers the whole process from clean production to treatment. The data collected can be used in further analysis.

Safer regulation and control: Big data technology is used to provide early warning on security and realize intelligent control of six types of security risk elements, including personnel, materials, process, equipment, environment and information in the production process. Independently developed software, systems and equipment are also used to enable integrated and collaborative prevention and control of functional security and network information security, thus realizing comprehensive security of networked and intelligent industrial applications.

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浙江凯华：
数字化转型为企业注入发展新动力

浙江凯华模具有限公司（以下简称浙江凯华）创立于 2000 年 12 月，专业从事汽车外饰系统、汽车内饰系统、冷却系统的注塑模具生产制造，并且可以为客户提供产品设计、模具制造、注塑成型、二次加工到装配的全方位解决方案。

数字化转型的背景和原因

工业互联网的高速发展赋予了新兴产业崛起的机遇。与此同时，互联网时代，自动化生产线和工业机器人的引入为模具制造的高质量发展提供了重要方向。对于传统制造业来说，新兴科技的冲击，和来自国内外市场大环境的日益严苛，都促使着企业进行数字化改造升级，谋求进一步发展。

在此背景下，作为台州市注塑模具行业领军企业的浙江凯华正处于极速扩张的关键时期，并且长期以来面临着业务流程缺乏标准化管理、信息传递不及时、品质管理缺乏保障以及数据管理缺乏精确性等问题，亟需系统化规范化的数字化管理来重塑企业内部体系，实现降本增效，增强企业的核心竞争力。

部门之间实现数据互通，解决了内部沟通困难、效率低下、责任认定难的问题。管理者能够通过数据报表精准掌握公司运营状况，合理制定下一步发展目标和规划。

数字化转型模式的三个路径

浙江凯华的数字化转型主要通过以下三个路径实现：

1.数字化软件完善

目前，浙江凯华已采用孚盟软件系统、U8 用友系统、维特标准化设计软件、益模智能制造系统、OA 协同办公软件五大软件系统。

销售人员通过孚盟软件系统建立客户数据档案，与客户联系取得销售订单，再通过用友 U8 下销售订单开始转到设计部门进行标准化设计，再

传回 U8 采购、入库，再回到益模系统开始生产制造，报工。模具在制造过程中，可以通过益模系统，及时下达生产指令，实时了解机床设备状态，实时监控整个项目进度、了解装配进程、安排试模计划，协调生产。中间的文件审批过程全部通过 OA 协同软件进行审批，最后数据汇总到财务，实现了五个系统数据的无缝对接，做到财务业务等公司流程的一体化管理，将繁琐流程所造成的人力成本和时间成本降到最低。

信息系统的高效运转体验，必须要有高性能的网络硬件设备支撑，凯华模具同步配制了高性能服务器、路由器、交换器，全公司千兆网络覆盖，并配制了防火墙，引进了 360 网络杀毒软件，在信息高效运转的同时也要保证网络安全。

2.标准化体系建设

浙江凯华成立以董事长为组长的标准化执行小组，各部门负责人全力配合标准化小组的标准推行工作，输出《凯华标准化零件手册》，流程标准化、模块标准化，并串联 U8、OA、EMAN 系统，大幅提升各职能部门的工作效率和可持续地降低成本。

做标准化工作之前，缺乏标准化的业务流程，导致生产过程混乱。销售订单传达、工艺文件下发以及物料采购不及时，造成排产困难，生产效率低下；设计、装配工艺完全按照个人习惯，模具品质得不到保障。通过建立系统化规范化的生产流程，各个部门在合理的生产计划下有序生产，实时掌握生产进度，给予客户相对准确的交期，交货准时率提升 30%。

3.先进数字化加工设备

自 2017 年开始，浙江凯华斥巨资持续购置德国 DMG、日本 MAKINO、意大利 FIDIA、德国 maffei 三色注塑机等全球顶尖数字化加工设备，打造无人工厂。如牧野自动化石墨生产线，该设备采用高度可重复生产过程的柔性系统，自动化的零件运输单元，系统地将加工中心，托盘装载，操作者连接起来，在几乎没有操作人员操作的情况下，从加工中心里得到加工完毕的零件，大幅降低了人工成本和加工出错率。

数字化转型所带来的明显效果

生产管理：建立了系统化规范化的业务流程，销售订单下单及时率提升 30%。同时有效管理工艺文件下发，及时提醒物料采购，生产效率提升近 50%，产值稳步上升。

品质管理：设计、装配等工艺按照标准化工艺走，大幅降低了模具设计、装配的出错率，极大提高了模具品质。

数据管理：通过系统对生产数据的采集，能够得到实时准确的数据，便于财务进行成本核算和应收款项催收，制定合理的资金流计划，解决了财务人工收集数据的难题，财务效率提升近 50%。

企业管理：部门之间实现数据互通，解决了内部沟通困难、效率低下、责任认定难的问题。管理者能够通过数据报表精准掌握公司运营状况，合理制定下一步发展目标和规划。

Zhejiang Kaihua:
Digital Transformation as A New Driver of Enterprise Development

Founded in December 2000, Zhejiang Kaihua Mold Co. Ltd. (hereinafter referred to as Zhejiang Kaihua) specializes in the manufacture of injection molds for automotive exterior and interior trim systems and cooling systems, and can provide customers with comprehensive solutions ranging from product design, mold manufacturing, injection molding, secondary processing to assembly.

Background and reasons for digital transformation

The rapid development of industrial Internet has given opportunities for the rise of new industries. At the same time, the Internet era, the introduction of automated production lines and industrial robots also provide an important direction for the high−quality development of mold manufacturing. For the traditional manufacturing industry, the impact of emerging technologies and the increasingly challenging environment of the domestic and international markets are prompting enterprises to seek further development through digital transformation and upgrade.

Against this background, Zhejiang Kaihua, as a leading enterprise in the injection mold industry of Taizhou City, is in a critical period of rapid expansion and has long faced such problems as lack of standardized process management approaches, untimely information transmission, less−than−guaranteed quality management and inaccurate data management. Thus, it is in urgent need of systematic and standardized digital management approaches to reshape the internal system of the enterprise, realize cost reduction and efficiency increase, and enhance

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its core competitiveness.

Three Pathways of Digital Transformation Model

Zhejiang Kaihua's digital transformation is mainly realized through the following three paths.

1) Digital software improvement

At present, Zhejiang Kaihua has adopted five major software systems, namely, Fumasoft's software system, U8 Yonyou system, UG NX Victor, Oureman's intelligent manufacturing system and OA collaborative office software.

Sales personnel first establish customer data files through Fumasoft's software system, contact customers to obtain sales orders, place sales orders through Yonyou's U8 and start to transfer to the design department for standardized design. Then they will get back to U8 for purchasing and warehousing and to Oureman's intelligent manufacturing system to start manufacturing. During the manufacturing process of mold, production orders can be made in time and the status of machine tools and equipment can be shown through the Oureman system, so as to monitor the progress of the whole project, understand the assembly process, arrange the trial mold plan, and coordinate production. The document approval process is all completed through OA software and the data will finally be gathered and directed to the finance department. In this way, it realizes seamless data connection of five systems and achieves integrated management of financial business and other processes, minimizing labor costs and time costs.

Data interoperability between department has facilitated internal communication, improved efficiency, and made tasks more accountable.

The efficient operation of information system must be supported by high performance network hardware, so high performance servers, routers and switches were equipped. Besides, company-wide gigabit network coverage and firewalls, as well as the 360 network antivirus software were also put in place to ensure efficient operation of information and network security.

2) Construction of standardization system

Zhejiang Kaihua set up a standardization implementation team led by the

Chairman. The heads of all departments actively cooperated with the standardization team in the implementation of the standard and developed the Kaihua Standardized Parts Manual. In this way, it has established standardized processes and modules, and linked U8, OA and EMAN systems, significantly improving the efficiency of each functional department and reducing the costs.

Before the standardization plan was implemented, the lack of standardized business processes often led to confusion in the production process. Delays in distribution of sales orders and process documents as well as materials purchase have resulted in scheduling difficulties and low production efficiency. Design and assembly processes completely relied on operators' personal habits, so mold quality was not guaranteed. However, by establishing a systematic and standardized production process, various departments can work under a reasonable production plan and track progress in real time, which increased the delivery on-time rate by 30%.

3) Advanced digital processing equipment

Since 2017, Zhejiang Kaihua has spent huge sums to acquire the world's top digital processing equipment from companies such as DMG MORI, MAKINO, FIDIA S.p.A, and KRAUSS-MAFFEI's so as to build up unmanned factories. For example, Makino's automated graphite production line uses a highly repeatable production process of flexible systems and automated parts transport unit, which systematically connects the processing center, pallet loading with operators. The parts can be produced in the processing center without any operators. Thus significantly reducing labor costs and processing error rate.

Achievements of digital transformation

Production management: A systematic and standardized business process was established, and the timely rate of sales order placement increased by 30%. At the same time, as the process documents are effectively managed and material procurement reminder becomes more in time, production efficiency is increased by

nearly 50% and output value is steadily rising.

Quality management: The design and assembly processes are based on the standardized processes, which significantly reduces the error rate of mold design and assembly and greatly improves the mold quality.

Data management: Through production data collected in the system, we can get real–time and accurate data, which is convenient for finance staff to carry out cost accounting and receivables collection and make reasonable capital flow plan, thus improving financial efficiency by nearly 50%.

Enterprise management: Data interoperability between department has facilitated internal communication, improved efficiency, and made tasks more accountable. Managers are able to accurately grasp the company's operation status through data reports and reasonably set development goals and plans.

上海电气集团：
工业互联网平台驱动数字化转型实践

上海电气是一家大型综合性高端装备制造企业，主导产业聚焦能源装备、工业装备、集成服务三大领域，致力于为全球客户提供绿色、环保、智能、互联于一体的技术集成和系统解决方案。产品包括火力发电机组（煤电、气电）、核电机组、风力发电设备、输配电设备、环保设备、自动化设备、电梯、轨道交通和工业互联网等。

随着全球化市场竞争加剧，传统制造业日益面临更加严峻的困难和挑战。国家提出要由"制造"向"创造"转变，利用工业 4.0、智能制造和云计算等技术，推进装备制造业转型升级。对上海电气而言，转型不仅要对内提质增效，更要形成对外赋能的产业。

成立于 2018 年的上海电气集团数字科技有限公司（以下称"上海电气数科"）是上海电气集团数字化产业发展和转型的关键载体和技术底座，面向高端装备制造业打造了集物联网、智慧供应链、企业管理信息化、数字化工厂、基础设施 & 云服务、数字办公等智能制造解决方案于一体的"星云智汇"工业互联网平台。星云智汇工业互联网平台由上海电气数科自主研发打造，建设过程中充分考虑通用性和专业性，针对火电、燃机、风电、机床、电机、轨交、环保、分布式能源、康复医疗等各产业应用需求进行扩展和实施，并基于各产业的经验和实践固化为行业解决方案，打造风电智能运维、火电远程运维、机床售后服务、储能电池综合管理、康复医疗机器人、环保分布式水处理系统等一批解决方案。平台将逐步从设备运维向生产管控、研发设计、服务增值全链条延伸。目前"星云智汇"工业互联网平台已服务于各类能源装备、工业装备等超过 10 万台高价值设备，管理资产价值超 1200 亿元。"星云智汇"工业互联网平台发挥应用场景优势和工业数据优势，推进智慧电厂、风电运维、综合能源管理等多领域的智能化应用。

随着全球化市场竞争加剧，传统制造业日益面临更加严峻的困难和挑战。国家提出要由"制造"向"创造"转变，利用工业 4.0、智能制造和云计算等技术，推进装备制造业转型升级。

在能源装备行业，能源技术正与物联网、云计算、大数据分析、人工智能等技术的深度融合，推动发电行业及企业的数字化转型。以工业互联网为代表的新兴技术正在改造和提升传统能源和新兴能源，并且使能源资本的配置实现区域化和全球化。利用工业互联网平台，将分布于不同地域、不同项目电厂数据进行集中采集、处理、存储、挖掘并进行集中监测与分析；通过人工智能、机器学习等先进大数据算法，打通、整合、协同产业链，从而提升企业产业集群效率。新能源智能运维管理系统以上海电气"星云智汇"工业互联网平台为基础，研发建设数据采集、生产监测、统计分析、预测运维、远程控制等智能化模块，实现对所有电力投运电站设备的综合管理，确保电站的安全和稳定运行，为后续电站的全生命周期管理、运营数据挖掘、设备设计优化等提供支持。

在智慧风电领域，将物联网、大数据、云计算、移动互联网等新兴技术应用到智慧风场的建设中，提供从风资源评估、风机选址、整体方案设计，到智慧监控、风场后评估、海上船舶调度管理的一体化服务。目前已接入风机超过 6000 台，在线设备数目保持在 60%，装机容量超 20GW。通过建立风电设备全生命周期管理系统，实现智能运维及运营策略，实现了多维度、智能化风电场生产运行情况分析及经营绩效分析。通过应用全生命周期数字化解决方案，"星云智汇"平台为风场资源选址人员提高了10%设计效率、实现设备资产全方位监控，平均降低 15 元 / 千瓦运维成本、提高了风场绩效管理，减少发电量损失 2%以上、确保了设备的高效运转，提升了 20%以上无故障运行时间。

总体来看，工业互联网在产业链整体的数字化转型中扮演着连接器的重要角色。因此，工业互联网平台应以优化产品服务为切入点，在提升企业生产精细化、智能化管理水平的同时，打造工业数据资产承载和分析能力配置的枢纽，在平台基座上构建多行业兼容、跨行业的工业平台与应用。"星云智汇"工业互联网平台一方面打造技术底座，另一方面重视生态化协同发展。基于平台的资源集聚、知识汇聚、信息链接能力，打造创新、开放、互利的工业互联网生态，推动产业链整体的转型升级。

Shanghai Electric Group:
Industrial Internet Platform Drives Digital Transformation in Practice

Shanghai Electric is a large integrated equipment manufacturing enterprise specialized in energy equipment, industrial equipment and integration services. It is committed to providing customers with solutions to technology integration and systems incorporating green, eco-friendliness, intelligence and Internet. Its products include thermal generator set (coal power, gas power), nuclear power units, wind power equipment, power T&D equipment, environmental protection equipment, automation equipment, elevators, rail transit and Industrial Internet, etc.

As global market competition intensifies, the traditional manufacturing industry is facing increasingly serious difficulties and challenges. The nation proposes a transition from "manufacturing" to "creation", and advises utilizing technologies such as Industry 4.0, smart manufacturing and cloud computing to drive the transformation and upgrading of the equipment manufacturing industry. For Shanghai Electric, the transformation not only means improvement in quality and efficiency internally, but also a formation of an externally empowering industry.

As a key carrier and technical base for Shanghai Electric in digital development and transformation, Shanghai Electric Group Digital Technology Co., Ltd. (hereinafter referred to as "Shanghai Electric Digital Technology (SEDT)"), which was established in 2018, has built a SEunicloud Industrial Internet Platform that incorporates the IoT, smart supply chain, enterprise management informatization, digital factory, infrastructure & cloud service, intelligent office and other smart manufacturing solutions for the high-end equipment manufacturing industry. SEunicloud Industrial Internet Platform is independently developed and set up

by SEDT. We took into full consideration the generality and professionalism in the construction of the platform, and expanded and implemented the platform for the application needs of various industries such as thermal power, gas turbine, wind power, machine tool, electric motor, rail transportation, environmental protection, distributed energy sources and rehabilitation therapy. It is solidified into industry solutions based on the experience and practice of each industry, creating a series of solutions like intelligent operation and maintenance of wind power, remote opera‐tion and maintenance of thermal power, after‐sales service for machine tools, comprehensive management of energy storage batteries, rehabilitation medical robots, environmentally friendly distributed water treatment systems. The platform will gradually extend from equipment operation and maintenance to the whole chain of production control, R&D design and value‐added services. At present, SEunicloud has served more than 100,000 units of various high‐value equipment such as energy equipment and industrial equipment, and the value of its managed assets exceeds 120 billion yuan. SEunicloud Industrial Internet Platform has taken advantage of application scenarios and industrial data to promote intelligent appli‐cations in various fields such as smart power plants, wind power operation and maintenance, and comprehensive energy management.

In the energy equipment industry, energy technologies are undergoing deep integration with the IoT, cloud computing, big data analysis and AI, etc., which bolsters the digital transformation of the power generation industry and enterprises. Emerging technologies represented by the Industrial Internet are transforming and upgrading traditional and emerging energy sources, which enables the regionaliza‐tion and globalization of energy capital allocation. Through the Industrial Internet Platform, data from power plants distributed in different regions and different pro‐jects are centrally collected, processed, stored, mined and centrally monitored and analyzed; improve enterprise in industry cluster efficiency by opening up, integrat‐ing and collaborating the industrial chain through advanced big data algorithms such as AI and machine learning. On the basis of Shanghai Electric SEunicloud In‐

In the energy equipment industry, energy technologies are undergoing deep integration with the IoT.

dustrial Internet Platform, the new energy smart operation and maintenance man—agement system develops and builds intelligent modules for data collection, pro—duction monitoring, statistical analysis, predictive operation and maintenance and remote control. They system realizes comprehensive management of all power station equipment in operation, ensures the safe and stable operation of the power station, and support the subsequent life—cycle management, operation data mining and equipment design optimization of the power station.

Regarding smart wind power, the platform applies new technologies like the IoT, big data, cloud computing and mobile internet to the construction of smart wind farms. It provides integrated services from wind resource assessment, wind turbine site selection, overall solution design, to smart monitoring, post wind farm assessment and maritime vessel dispatch management. At present, more than 6000 wind turbines have been connected, of which 60% devices remain online, with an installed capacity of exceeding 20Gw. By establishing a lifecycle management sys—tem for wind turbines, we realize smart operation and maintenance and operational strategies, as well as multi—dimensional and intelligent analysis of wind farm pro—duction and operation performance. Through the utilization of the digital solution for the whole lifecycle, the SEunicloud platform has improved design efficiency by 10% for wind farm site selectors, enabled comprehensive monitoring of equipment assets, reduced operation and maintenance costs by an average of 15 RMB/kW, improved wind farm performance management, reduced power generation losses by more than 2%, ensured efficient operation of equipment, and increased trou—ble—free operation time by more than 20%.

In general, the Industrial Internet plays a key role as a connector in the overall digital transformation of the industrial chain. Therefore, the Industrial Internet Platform should take product services optimization as the entry point to improve refined and intelligent management of enterprise production, build a hub for in—dustrial data asset bearing and analysis capacity configuration, and set up multi—in—dustry compatible and cross—industry industrial platforms and applications on the

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base of the platform. On the one hand, SEunicloud Industrial Internet Platform creates a technical base, and on the other hand, it attaches importance to ecological and collaborative development. Benefited from the platform's ability to gather resources, converge knowledge and link information, an innovative, open and mu−tually beneficial Industrial Internet ecology will be created to promote the transfor−mation and upgrading of the overall industrial chain.

中德智能制造联盟
Alliance for Sino-German Intelligent Manufacturing