

只有坚韧不拔才有成功希望

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2025年5月底,刘友梅院士和我在北京接受了中国中车株洲电力机车公司“铁路文化会客厅”栏目组的采访,共同回顾了1958至1968十年间中国研制“韶山型”电力机车的峥嵘岁月。我们两人都是1961年参加工作来到株洲的,他在株洲(田心)机车厂(以下简称“株洲厂”),我在株洲电力机车研究所(以下简称“株洲所”)。

众所周知,电力牵引具有功率大、载运能力强、爬坡性能好等优点,这些对于山区铁路提高运输能力尤为重要。20世纪50年代末,宝成铁路运输能力高度饱和,其中宝鸡—凤州区段坡道又长又陡,成为“卡脖子”区段。铁道部决定对宝凤段实施电气化改造,这就需要有电力机车。那时我国工业底子薄,只能生产蒸汽机车。后来我国开始仿制苏联H-60型电力机车,第一台机车于1958年在湘潭电机厂组装下线,被命名为6Y1型。从1959年开始,电力机车改由株洲厂组装生产。不过,所生产的电力机车由于技术不过关,无法正式投入运行。

1960年,宝鸡—凤州电气化铁路已经建成,急需电力机车,可是6Y1型电力机车技术不过关。在这节骨眼上,苏联突然撤走了前来指导的专家,这真是雪上加霜!这一事件让满怀激情、初涉电力机车领域的年轻技术人员,瞬间陷入了迷茫之中,然而“被人遗弃”的羞辱感却激发了年轻人发愤图强的使命感,不相信离开洋人就一事无成。经过一段时间的冷静思考大家认识到,苏联开发交流电力机车也只不过几年工夫,我国仿制电力机车所暴露的问题实际上是重蹈覆辙——电力机车“三大件”,即牵引电机、引燃管整流器、调压开关的技术都不成熟。这群年轻人一致认为,对原有设计不动大手术是不行的,继续沿着苏联的技术路线走,还不如自己另辟蹊径。

在铁道部领导下,株洲厂、株洲所组建了研发团队,联合攻关。联合研发团队在不断改善研究试验条件的同时,集中骨干力量,分解各个零部件,夜以继日地开展技术攻关,终于找到问题所在,先后成功研制出了新型牵引电机,用半导体硅整流器取代水银引燃管,并改进了调压开关。联合研发团队苦战十年,历经多次失败、多次反复,在1968年终于实现了6Y1型第008号电力机车的技术过关。同年,铁道部果断地做出决定,把6Y1—008号电力机车车型正式定名为“韶山1型”(SS1)电力机车,并于1969年开始小批量生产,成为我国电气化铁路的主型机车。

在自主创新的日子里,涌现出了许多优秀的骨干人才。这一次在北京同时接受采访的刘友梅院士就是一位杰出代表。刘友梅毕业于上海交通大学电力机车专业,毕业后来到湖南株洲——这个中国电力机车的摇篮,参与电力机车技术攻关。经过多年的实践锻炼,他先后成为机车的总体设计师和株洲电力机车厂的总工程师,亲历了中国电力牵引从无到有、从弱到强、从普载到重载、从普速到高速的升级全过程,他对我国电力牵引的技术进步做出了重要贡献。1999年他当选为中国工程院院士。2002年11月27日,他主持设计的“中华之星”高速动车组,在秦沈客运专线上跑出了321.5 km/h的当时中国铁路最高速。

忆往昔,深感自主创新之不易。联想到近30年来中国高速列车“从无到有”,到“引进、消化、吸收、再创新”,再到“自主创新”的发展历程,体会到核心技术是买不来、讨不来的。对于高铁的列车控制、牵引、制动、转向架、车体等一系列核心技术,我国科技工作者都经历了独特的创新过程。韶山型电力机车与复兴号高速列车的成功,说明了一个道理:科技创新没有坦途和捷径可走,企图站在别人的“肩膀”上是靠不住的,必须自力自强,艰苦奋斗。只有坚韧不拔,不退却、不放弃,探索和创新才有成功的希望。

(下转第275页)

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Commentary

Only through Perseverance Can Success Be Expected

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At the end of May 2025, Academician LIU Youmei and I were interviewed in Beijing by the production team of the CRRC Zhuzhou Electric Locomotive Co., Ltd. program 'Railway Culture Guest Room'. Together, we looked back on the eventful decade from 1958 to 1968, during which time China developed the 'Shaoshan' electric locomotive. Both of us came to Zhuzhou for work in 1961—he at the Zhuzhou (Tianxin) Locomotive Factory (hereinafter referred to as the 'Zhuzhou Factory') and I at the Zhuzhou Electric Locomotive Research Institute (hereinafter referred to as the 'Zhuzhou Institute').

It is widely known that electric traction possesses advantages such as high power, strong load capacity, and good climbing performance, that are features particularly vital for enhancing transport capabilities in mountainous railway regions. By the late 1950s, the Baoji-Chengdu Railway had reached full capacity. Along its route, the steep and lengthy Baoji-Fengzhou interval became a major bottleneck. The Ministry of Railways decided to electrify this section, which in turn required electric locomotives. However,

China at the time had a weak industrial base and could only produce steam locomotives. Subsequently, China began to imitate the Soviet H-60 electric locomotive model. The first locomotive was assembled in 1958 at Xiangtan Electrical Machinery Plant and designated as Type 6Y1. Starting in 1959, the assembly and production of electric locomotives were transferred to the Zhuzhou Factory. Yet, due to technical shortcomings, the locomotives produced were not fit for official operation.

By 1960, the Baoji-Fengzhou electrified railway had already been completed and was in urgent need of electric locomotives. However, the 6Y1 model suffered from severe technical deficiencies. At this critical juncture, the Soviet Union abruptly withdrew the experts it had dispatched for technical guidance—adding insult to injury! This incident left the young engineers, who had just entered the field of electric locomotives with great enthusiasm, in a state of confusion. Yet, the humiliation of being ‘abandoned’ sparked a sense of mission among them, driving them to strive harder and reject the notion that the cause was doomed without foreign assistance. After a period of calm reflection, realization came that the Soviet Union itself had only been working on AC (alternating current) electric locomotives for a few years. The issues exposed in China’s imitation process were, in fact, a repeat of earlier mistakes—the three core components of electric locomotives, namely the traction motor, ignitron rectifier, and voltage regulating switch, were all technically immature. The young engineers unanimously agreed that it would be futile to continue without making major changes to the original design. Rather than blindly following the Soviet technical route, it would be better to blaze their own trail.

Under the leadership of the Ministry of Railways, the Zhuzhou Factory and the Zhuzhou Institute formed a joint R&D (research and development) team to tackle technical challenges collaboratively. While continuously improving research and testing conditions, the joint R&D team concentrated its core personnel and broke down each component for in-depth analysis, working tirelessly day and night on breaking through key technological problems. Eventually, the root causes were identified and a new type of traction motor was successively developed, replacing the mercury-ignitron rectifier with a semiconductor silicon rectifier and improving the voltage regulating switch. After ten arduous years and numerous failures and iterations, the joint team finally overcame the technical hurdles of the 6Y1-type No. 008 electric locomotive in 1968. That same year, the Ministry of Railways decisively announced that the 6Y1-008 electric locomotive would be officially designated as the ‘Shaoshan 1’ (SS1) electric locomotive. In 1969, it entered small-scale production, becoming the main locomotive model for China’s electrified railways.

During this period of independent innovation, many outstanding key personnel emerged. Among them was Academician LIU Youmei, who also participated in the interview in Beijing. LIU graduated from the electric locomotive program at Shanghai Jiaotong University and, upon graduation, came to Zhuzhou, Hunan—the cradle of China’s electric locomotives—to join in tackling technological challenges in the field. After years of hands-on experience, he successively became the chief designer of locomotives and chief engineer of the Zhuzhou Electric Locomotive Factory. He personally witnessed the full course of development in China’s electric traction sector—from nothing to something, from weak to strong, from standard-load to heavy-haul, and from normal-speed to high-speed. He made significant contributions to the technological advancements in electric traction in China. In 1999, he was elected as an academician of the Chinese Academy of Engineering. On November 27, 2002, the ‘China Star’ high-speed EMU he led in designing achieved a speed of 321.5 km/h on the Qinhuangdao-Shenyang Passenger-dedicated Line—the highest speed ever recorded on China’s railways at the time.

Looking back, it shall be profoundly recognized how difficult independent innovation truly is. Reflecting on the development path of China’s high-speed trains over the past 30 years—from having ‘nothing to something’, to ‘introducing, digesting, absorbing, and innovating (on the basis of foreign technologies)’, and eventually achieving ‘independent innovation’—it becomes clear that core technologies cannot be bought or begged for. In core areas for high-speed railway such as train control, traction, braking, bogies, and car body, China’s scientific and technological scholars have all undergone a distinct and original innovation process. The success of the Shaoshan-type electric locomotives and the Fuxing high-speed trains proves one fundamental truth: scientific and technological innovation has no smooth path or shortcut. It is unreliable to expect standing on the ‘shoulders’ of others—self-reliance and hard struggle are essential. Only through perseverance, without retreat or giving up, can exploration and innovation lead to the hope of success.

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