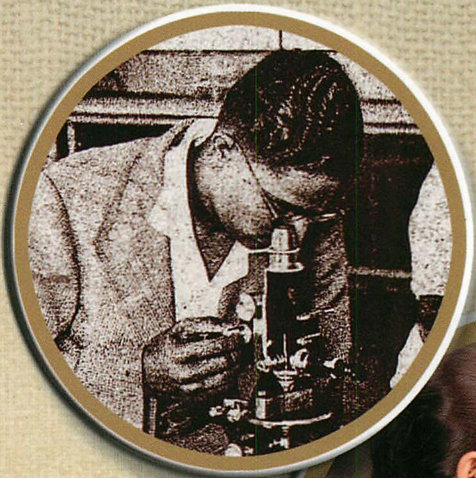
75 Pathfinders of Excellence

years of research at Tata Steel



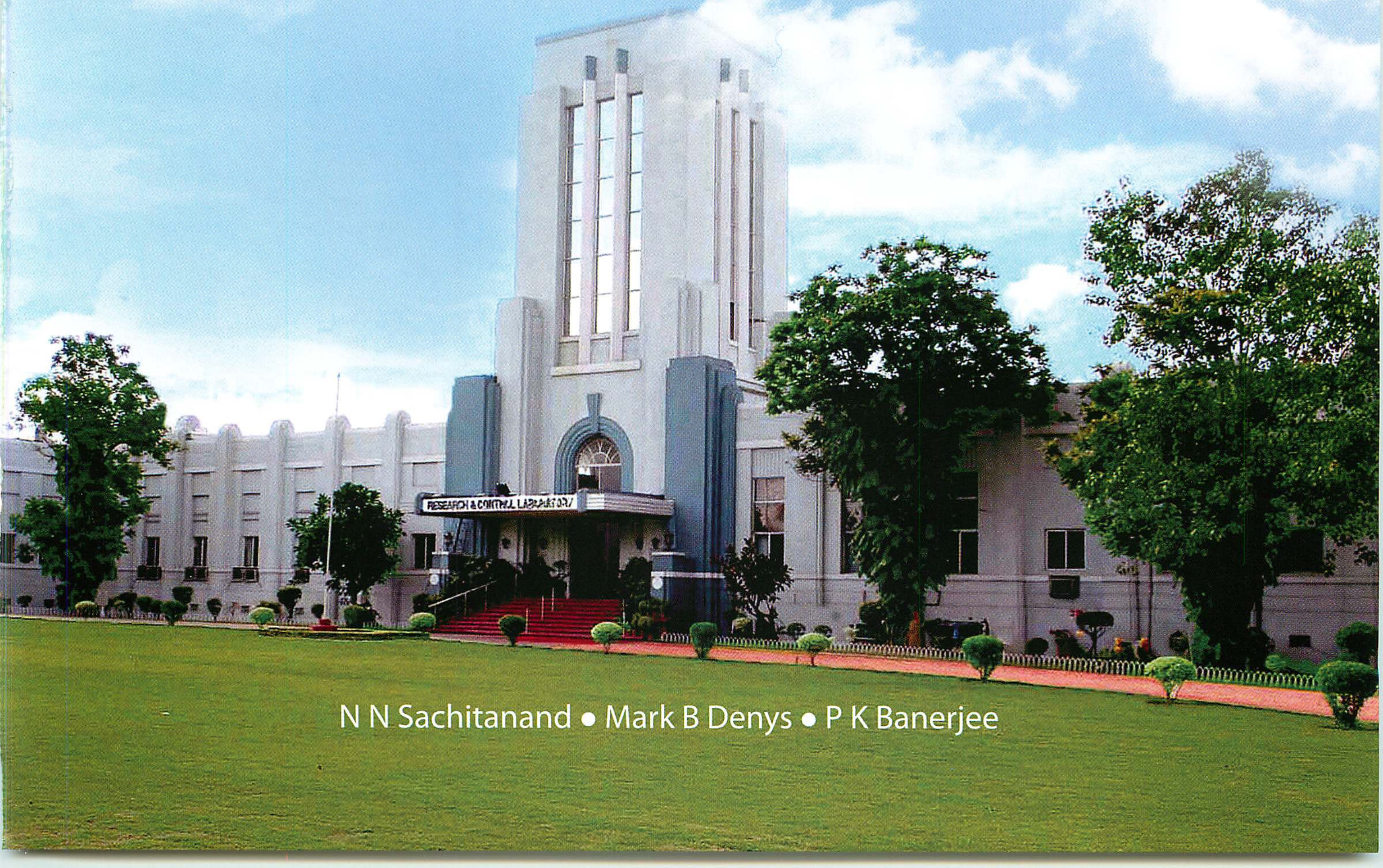
N N Sachitanand • Mark B Denys • P K Banerjee

Pathfinders of Excellence

TATA
TATA STEEL

Pathfinders of Excellence

75 years of research at Tata Steel



N N Sachitanand • Mark B Denys • P K Banerjee

Pathfinders of Excellence
75 years of research at Tata Steel

is an Institutional Publication of Tata Steel
R&D and Scientific Services Division, Jamshedpur
crdssoffice@tatasteel.com

Editorial Team

Tanmay Bhattacharyya
Monojit Dutta
Ishant Jain
Sri Harsha Nistala
Ravi Golani
Anindita Chakraborty

ISBN : 978-93-5087-583-4

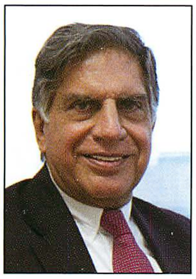
Design & Print

Kailash Paper Conversion (P) Ltd.
www.kailashpaper.org

This book is dedicated to

Jamsetji Tata
Founder, Tata Group

Message



Ratan N Tata
Chairman

It was in 1937 that Tata Steel set up the Research & Development and Scientific Services Division, thereby pioneering corporate R&D in India. This book presents an engaging account of how the last 75 years of work by the division has brought innovation and excellence to Tata Steel and the Indian Steel Industry. It is a story of inspiration, imagination, hard work and great achievements by researchers, engineers and scientists.

As had been envisaged by its founders, the division has supported Tata Steel in its growth and successfully helped the company meet the ever more stringent requirements for quality products from safe and sustainable production processes.

The division's track record is truly impressive. Whilst being only a fledging laboratory in the early 1940s, the division successfully developed no less than 110 different varieties of steel, among which the well-known examples are the ballistic steel grades used in the Tatanagar armoured vehicles, the (then) new steel rails for the Indian Railways and the weather-resistant steels for the old Howrah bridge in Calcutta.

Over time, the division has pioneered many more innovations. These have contributed substantial value to Tata Steel and its stakeholders and resulted in a large number of patent applications, publications of papers in leading international journals, and national and international awards.

The story of Tata Steel's Research & Development and Scientific Services Division is also a reflection on the growth in the impact of research and sciences in all aspects of industry, both in India and overseas. The most important change this book details is how the role of research has evolved from being a fringe activity to a core activity since robust R&D is now seen as essential for sustained success in any business.

Looking ahead, the role of R&D will only gain in importance as companies seek to be more innovative in order to be more competitive. This book will inspire the present and future generations of researchers, engineers, scientists and business leaders and I am pleased to commend it to readers.

August 3, 2012

Ratan N Tata

TATA SONS LIMITED

Bombay House 24 Homi Mody Street Mumbai 400 001

Tel 91 22 6665 8000 Fax 91 22 6665 8001 e-mail coffice@tata.com

Message

TATA

Cyrus P Mistry
Deputy Chairman

I am delighted to know that the Research & Development and Scientific Services Division of Tata Steel will celebrate 75 years of existence this September. My compliments to the entire R&D team for what they have been able to achieve over the years that has brought glory and pride for the Division and the Company.

The coming years are full of challenges for all of us. To meet the varying demands of the discerning customers; our manufacturing practices have to embrace the passion to innovate and offer new products based on newer technologies. Innovation will hold the key for success, and our R&D team should lead on the crest of technological innovation and set technological benchmarks. These could be in the sphere of innovation of new products, process improvements and in greener technologies to reduce carbon footprint.

On this momentous occasion of its 75th year of existence, let me take this opportunity to congratulate the Research &. Development Department team of Tata Steel and wish them success in their initiatives to take Tata Steel to a more Illustrious phase going forward.

June 14, 2012

C. P. Mistry
Cyrus P Mistry

TATA SONS LIMITED

Bombay House 24 Homi Mody Street Mumbai 400 001
Tel 91 22 6665 7555 Fax 91 22 6665 7559 e-mail dcoffice@tata.com

B Muthuraman
Vice Chairman

Tata Steel was the first steel company in India and one of the earliest in the world to realize the importance of research and to establish a Research and Development Division way back in 1937. As it completes 75 years of eventful history, I wish to pay a tribute to many of its illustrious personalities of the past and present who have contributed in great measure to the success of R&D efforts and consequently of Tata Steel's success over these 75 years.

Years ago, at a time when Tata Steel did not possess adequate and proper facilities for the manufacture of specialized steels, it is the R&D division that enabled it to produce steel for armour plates, battle tanks and for cutting tools, as efforts to help India during war times. Later, steels like the high tensile steels, wear resistant steels, corrosion resistant steels, high carbon and alloy steels were all due to the efforts of R&D and were beyond the capability that existed for processing these steels.

With India's meager reserves of iron ore and poor quality of coking coals, it is only natural that the more recent efforts of R&D were focussed on mineral beneficiation and getting the best out of our mineral reserves, keeping in mind conservation and sustainability. Tata Steel is on the verge of a major breakthrough in bringing down the ash levels in-our coking coals to dramatically low levels without undue loss in yields. This is a path-breaking achievement.

Our R&D division has contributed immensely in making Tata Steel a globally competitive and sustainable enterprise. The Steel Industry is ripe for the development of a new process that will reduce emissions dramatically, that will consume less energy, that will use mineral resources in the most optimal manner and which will significantly lower the steel cost curve. It will only be fitting for Tata Steel's R&D to begin efforts to bring in such a process into commercial reality.

On its 75th year, it gives me great pleasure to congratulate the people of Tata Steel's Research & Development division and wish them continued success.

August 21, 2012

B Muthuraman

TATA STEEL LIMITED
Bombay House 24 Homi Mody Street Fort Mumbai 400 001 India
Tel 91 22 6665 7499 6665 8111 Fax 91 22 6665 8118
e-mail muthuraman@tatasteel.com

Message

H M Nerurkar
Managing Director

It is a matter of pride for Tata Steel that its Research & Development and Scientific Services Division has the distinction of being the first of its kind in India and is set to celebrate 75 years of its existence this year. Since its inception, the division has been actively engaged in adding value to the company in terms of quality assurance, enhancement of existing processes and the development of new products and has been a consistent driver of innovation in the Indian steel industry. I must commend the efforts of all those who contributed to the growth of the division and made it the great institution it is today.

The steel industry is today facing critical challenges in terms of rising costs, difficulties in raw material availability, increasing competition from alternate materials and a rising demand for more eco-friendliness. I am sure the division will rise to the occasion to meet these challenges and provide support and competitive advantage to the company through innovations in processes, technologies and products.

I am very pleased that the division has taken the initiative to document its long and illustrious journey in the form of this book. I am sure the book will appeal to a wide audience of scientists, engineers, managers, businessmen, students and even laymen. I take this opportunity to convey my best wishes to the staff of the Research & Development and Scientific Services Division as they prepare to tackle the many challenges in the years to come.

August 29, 2012

H M Nerurkar

TATA STEEL LIMITED

Jamshedpur 831 001 India
Tel 91 657 2424602 2145625 Fax 91 657 2431818 e-mail hmnerurkar@tatasteel.com
Registered Office Bomby House 24 Homi Mody Street Mumbai 400 001

Message

TATA

Debashish Bhattacharjee
Director, Global RD&T

I am delighted that the Jamshedpur R&D centre (R&D and Scientific Services Division) is celebrating its 75th year through the publication of this commemorative volume. This chronicle of the achievements of the researchers and engineers of Tata Steel will find an important place in the annals of Indian science and technology.

In its early years, this Division of Tata Steel was obviously the hub of the company's technical discussions as seen from the comments and signatures left in the visitor's books of 1940s by many very important national and international technical, social and political leaders. During those years, this centre led the development of rail steel grades and steels for armour applications and bridge construction.

From then till the end of 1990s, the Jamshedpur R&D centre closely supported the business in improving yield at various stages of operations and in optimizing new products for the Indian market to suit the production process. Significant improvements in blast furnace performance, continuous reduction of ash in washed coal and improvement in surface quality of cold rolled products for automotive applications were achieved during the last two decades of the 20th century. The first decade of the new millennium saw a paradigm shift in R&D programme with focus on strategic imperatives such as raw materials utilization, new materials and new markets, energy and environment and step change in cost and yield.

Breakthrough projects such as attaining 8% ash without reducing yield, zero reject iron ore, 30% reduction in production cost of ferro chrome, hydrogen harvesting and steels with ultra high strength and good formability were initiated and have progressed to some maturity. These projects are potential game changers in the steel industry.

Now that the Jamshedpur R&D centre is part of a bigger global organization, its access to European technologies and expertise is easier. In the next 5 to 10 years, the Jamshedpur R&D centre, together with its sister centres in Netherlands and the UK, need to provide thought and technical leadership to the company by having a healthy technology roadmap, developing high margin products and quickly implementing significant process improvements.

I wish the team all the success.

August 24, 2012

Debashish Bhattacharjee

Tata Steel Research, Development & Technology / IJmuiden Technology Centre
Address code 3G37 PO Box 10000 1970 CA IJmuiden The Netherlands
T: +31 251 491428 F: +31 251 470114 E: debashish.bhattacharjee@tatasteel.com
Tata Steel Nederland Technology B.V. Trade register 34083341

Contents

JRD Tata, then Chairman of Tata Sons Ltd., being escorted into R&D Centre by Dr. J J Irani, on a visit.

The Industrial Revolution in the mid 19th century ushered in a new world economy based on manufacturing using machine power. Western Europe was the first to experience the transformation. India, as the premier colony of the British Empire, was also quick to face this trend when it established steam powered textile mills and the development of a railway network. In turn, this created a market for spares and components, mostly of iron and steel.

Jamsetji Nusserwanji Tata, a visionary textile magnate based in Bombay, realised the enormous potential of this emerging market. Towards the end of the 19th century he moved to establish a company that would manufacture steel for the country's nascent industrial economy.

The Tata Iron and Steel Company (now Tata Steel) was incorporated in 1907 and the first steel ingot was rolled in February 1912. As a pioneering steelmaking venture in India, Tata Steel faced scepticism about its ability to deploy technology that was new to India. This was compounded by various infrastructure constraints due to the plant's remote location and the less than ideal quality of locally available raw materials.

An important factor to overcome these challenges was the emphasis, right from the beginning, on research, development and quality control using scientific approaches. Initially, this focussed on meeting production and quality requirements, despite raw material inadequacies. As the company gained the confidence, stature and the trust of the market, its research and development activities also entered more complex areas, such as new product development, process innovations and even exploratory work into various world first technologies.

All this has kept Tata Steel in the forefront of the Indian steel industry and maintained its competitiveness in the world steel market. In a country where historically investment in industrial research has not been very forthcoming, Tata Steel has been an outstanding exception.

In 1937 Tata Steel was the first Indian company to create a corporate research department. Its start meant the birth of Industrial R&D in all of India. It is a tell-tale sign of the vision and enlightenment of the 'House of Tata' to set up such a then 'Western' concept in the remote township of Jamshedpur.

While a number of books have been published about the Tata Steel story, the company's glorious and gritty research and development saga was not yet documented comprehensively. This book attempts to fill that gap and is published on the occasion of the Platinum Jubilee of the company's Control and Research Laboratory, now known as the R & D and Scientific Services Division.

The first few chapters of this book recount the early efforts of the company to generate a research and development culture within the organisation and to meet the requirements of the market. This began with establishing testing and analysis facilities and procedures to meet the qualitative demands of its first customer – the Indian Railways. The painstaking efforts of Dr. Andrew McWilliam, a professor from Sheffield University contracted by the Railways as a Metallurgical Inspector, to establish the systems of quality control in the fledgling steel company has been highlighted. The onset of the First World War and the fact that Tata Steel was the only integrated steel plant in the Asian part of the British Empire gave an opportunity to the company's engineers and metallurgists to experiment with producing steel for armaments that were required by the British Forces in the Middle East. This expansion into the new products further strengthened the push for research.

The logical next step was the establishment of a R&D department and a central laboratory. That came in the latter half of the 1930s. The chapter on this central laboratory elaborates on its architecture, facilities, safety features and capabilities. This large and well-equipped R&D facility was directly able to meet the needs of the day. This is recalled by the chapter that details how Tata Steel was able to quickly develop special and alloy steels to be used in armaments for the Allied Forces during the Second World War.

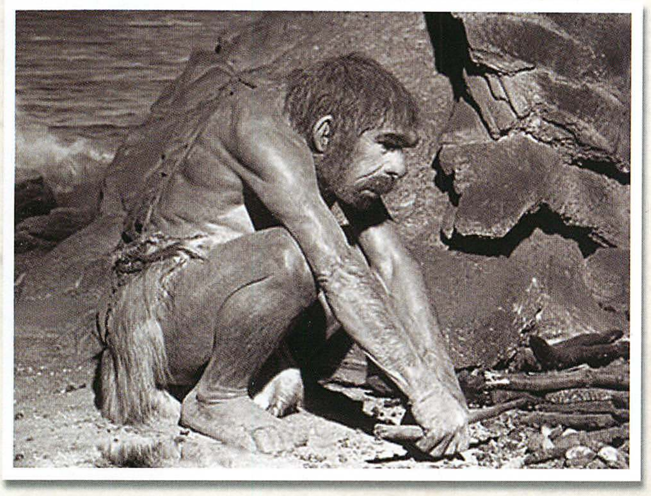
Post Independence, Tata Steel expanded its capacity and inducted new technologies to meet the growing requirements of a developing and modernising India. In this phase, the laboratory played a pivotal role in technology absorption, productivity improvement, specific energy reduction, quality enhancement, new product development, etc. In particular, it supported the company immensely to overcome the handicap of poor quality indigenous mineral resources. These efforts are detailed in the chapters devoted to hot metal, steel and products.

Research and development is not just about scientific laboratory work. It also concerns able project selection and management, human resource development and, in these days of a competitive global environment, protecting and exploiting intellectual property. How the R&D and Scientific Services Division of Tata Steel has tackled these issues is dealt with in the last few chapters of this book. Finally, the book concludes with the challenges posed to the R&D and Scientific Services Division in the 21st Century, with a particular reference to the fact that Tata Steel has become a major global steelmaking company through its recent acquisitions.

The preparation of such a book involved cooperation from large number of agencies, divisions and individuals. The editorial team would like to express their sincere appreciation towards everyone associated with the formulation of this book, including all the employees of R&D and Scientific Services Division. A special mention is necessary for Prof. O N Mohanty, Mr. U K Jha, Mr. P V T Rao and Dr. M D Maheshwari for their valuable insight into R&D's past. The technical contributions and useful suggestions from Dr. S K Ajmani, Dr. A N Bhagat, Dr. M Shome, Mr. Atanu Ranjan Pal, Dr. Sumitesh Das and Dr. Sandip Bhattacharyya are thankfully acknowledged. Throughout the writing of the book, we had received constant help and support from Ms. Jenny Shah, Mr. Swarup Sengupta and Mr. Prabhat Sharma for the historical archives of R&D. The photographs are courtesy to Mr. DAS Murthy. And finally, we sincerely thank Mr. H M Nerurkar, Managing Director of Tata Steel, for his support to this book on the occasion of 75 years of R&D in Tata Steel.

Jamshedpur,
August 31, 2012

N N Sachitanand
Mark B Denys
P K Banerjee



We commence with a story...

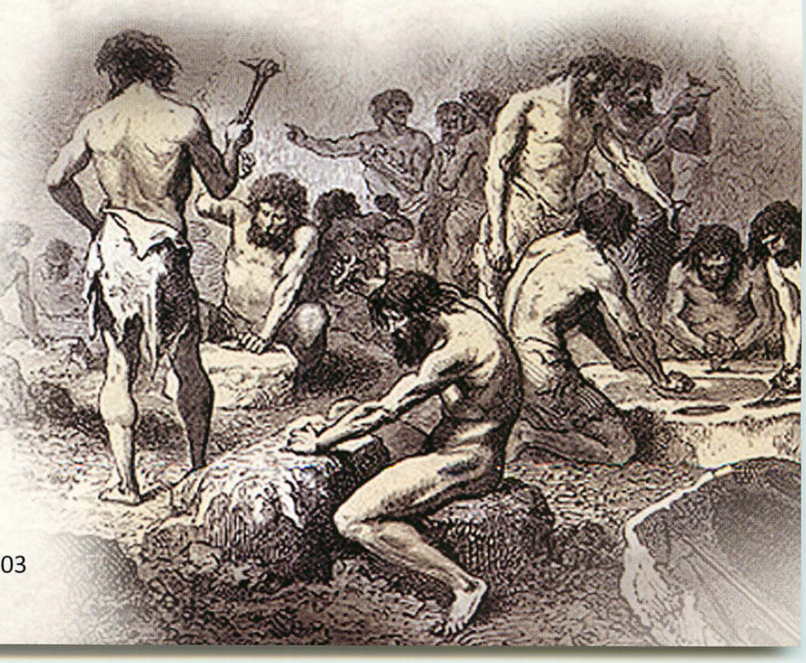
Urguk was idly flinging pebbles at a nearby rock as he basked in the morning sun. The warmth of the day was a relief after the cold night in the cave where he and his fellow tribesmen had taken refuge. Suddenly, something peculiar caught his attention. Sometimes, a bright flash of light emanated from the spot where a pebble struck the rock. The flame reminded him of the tree-devouring Red Monster that rose when the Cloud God suddenly hurled his dazzling weapon towards the earth with an ear-splitting sound.

Urguk's curiosity was aroused. The next time a pebble caused a light flash, he rose up, retrieved it and again hurled it at the rock. There was the flash again! Now he became more daring. He grasped the pebble and slashed it across the rock. Sure enough, the light flashed again! As he struck the rock again and again, one flash leapt from the rock onto the surrounding dry grass that immediately burst into flames.

At first, Urguk was unnerved. "It is the Red Monster!" he thought. He dropped the pebble, stepped back a few paces and got ready to run. But once the blades of grass were consumed, the wisp of flame died down. Emboldened, Urguk cautiously approached the rock again and looked speculatively at the blackened grass that was warm when touched. On an impulse, he plucked tufts of dry grass, put them around the rock and again started striking it with the pebble. Sure enough, one of the sparks set the grass alight.

Urguk knew he had found something special - the power to summon the Red Monster when he wished, with the help of the magic pebble. Of course he could not have realised how epochal his discovery of lighting a fire would be. Nor did he appreciate that the means to the discovery is what research is all about: observation, experimentation, analysis and conclusion. Down the ages, it is such research that has led to breakthrough discoveries - agriculture, cooking, irrigation, the wheel, free-standing structures, transport, script, astronomy, geography, metallurgy, biology, medicine and so on. All this has raised the level of human development in quantum steps.

This is also the story behind the biggest game changer in the history of human development: the Industrial Revolution. This event occurred primarily due to the development of the steam engine and the internal combustion engine, which enabled motive power in a compact form at levels not feasible with the muscle power of humans or animals.




Industrial Revolution

The Industrial Revolution radically altered the position of steel in the world. From a rare exotic material used mainly in weaponry, it became a universally available material used in a wide variety of applications. This was rendered possible by the development of large scale steelmaking processes that exploited the engines of power invented during the Industrial Revolution. The 20th century became known as the Century of Steel and the material became central to economic prosperity, political power and international prestige.

The Industrial Revolution was transplanted to colonial India in the latter half of the 19th Century. This coincided with the genesis of the movement for self-rule that became the precursor of the Independence Movement. Indian businessmen who had started as traders now turned industrialists. Instead of just exporting raw materials and importing manufactured goods, the country slowly started on the path towards large scale manufacturing.

Amongst these industrialists was Jamsetji Nusserwanji Tata, a cotton textile magnate from Bombay. Although he refused to appear on public political platforms, he was a strong nationalist and desired self-government for India through constitutional means. But he considered economic self-reliance for India to be equally important. Jamsetji's vision was of a self-supporting, strong industrial India, of ships built in India carrying goods made in India to far flung markets across the oceans.

A widely travelled person, Jamsetji had seen how the production and use of steel had led to the rapid development and empowerment of Western Europe and the USA. This motivated him to set up a modern steelworks in India. After a lot of tribulations, it finally started operations in 1907. Unfortunately Jamsetji did not live to see this dream turn to reality as he passed away in 1904.

How accurate Jamsetji was in his prediction of the importance of steel can be gauged by the following comment of Sir Thomas Holland, then Director of the Geological Survey of India. He declared in 1923 that *"without steel manufacture on a large scale and, therefore, for the near future at least without the Tata steel company, there can be no national India and all political reforms must be non-productive".*

The Industrial Revolution altered the paradigm of manufacturing from dispersed small scale to concentrated large scale. Leadership in technology became a critical agent for achieving business leadership. Those companies and countries that invested in scientific thought, research and development raced ahead.

There was a time when nations could build walls against imports and their industries could manage with outdated technologies. Globalisation and the dismantling of trade barriers have ended that. Today, enterprises have to be globally competitive. One of the fundamental means is to stay ahead to servive in research and development.

Tata Steel incorporated the spirit of research and innovation right from its inception, when the country's organised industry was still in its infancy. Jamsetji Tata was a man who appreciated the value of science. In his 1925 biography of Jamsetji, Frank Harris remarks *"The bent of Mr. Tata's mind inclined towards those who were advocating greater attention to scientific studies. He was much impressed with the progress of the rising Powers. He saw in America, Germany and Japan the prosperity,which the application of science to industry has already produced."*

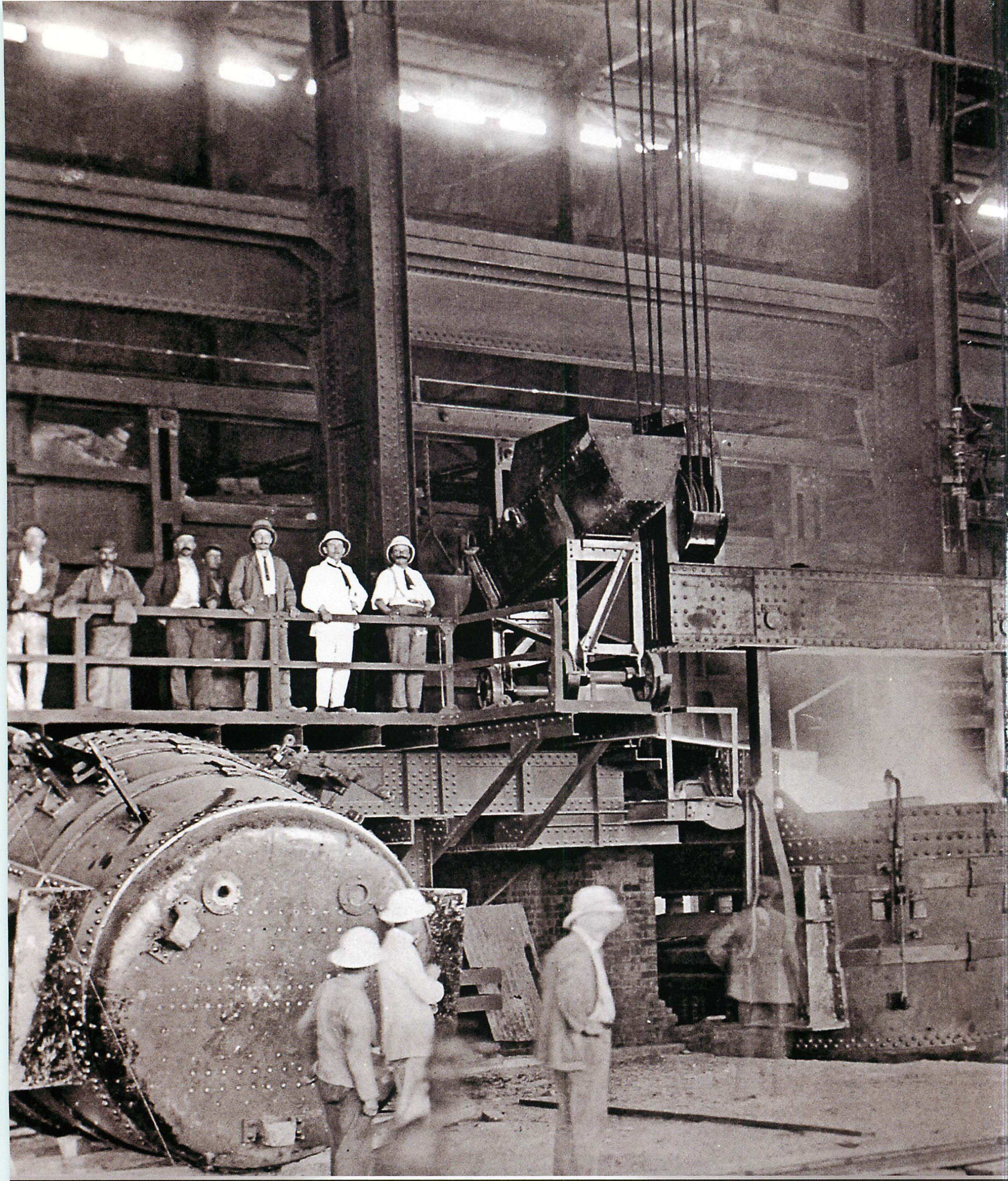
It is this application of science to industry, what is now termed Industrial Research & Development (R&D), that has played a crucial role in the shaping and growth of Tata Steel. This industrial research is rarely about "eureka" moments or paradigm-shifting innovations. The path of scientific discovery may be hacked through the jungles of the unknown by brilliant and obsessed individuals; however, industrial research works more systematically and collectively on these paths to turn them into highways of value creation.

In the public mind, innovation is what hits the news headlines with the promise of a breakthrough that may change the world. Any Industrial R&D organisation will devote part of its resources to pursue the path of such breakthrough innovation. These are the risky, costly and long-term developments that, once successful, can generate large returns.

However, this is just the iceberg of innovation. Most research and development exists out of sight. Most of the time, it is tiresome experimentation, modelling, piloting with many blind alleys from which the researcher has to backtrack. This part of industrial research is focused on continuous improvement; taking many incremental steps that are individually small but cumulatively over time become game changers for an industry.

Very few researchers in industrial research become stars of the scientific firmament, but their collective contribution can change the fortunes of a company, industry, even society. There is more to industrial research than just science. There is planning, costing, resource management, project monitoring, human resource development, motivation management, intellectual property protection and a host of other activities.

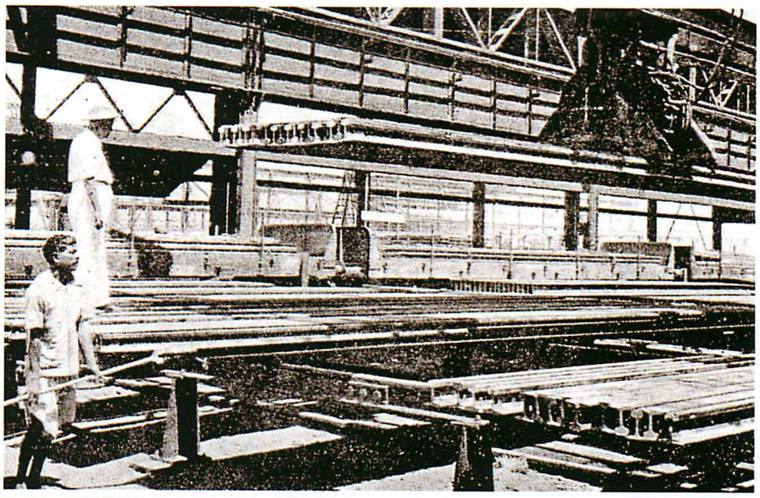
How Tata Steel has introduced, handled and polished all these facets of industrial research makes a fascinating tale. While there have been numerous books, monographs and articles written about Tata Steel and its founders, little is known about this formative role of its R&D and Scientific Services Division. This book intends to tell that story. It is also a tribute to the dedication of the numerous persons who have unobtrusively but conscientiously done their part for the welfare and success of Tata Steel.



Open Hearth Steel Furnace

" Do you mean to say that Tatas propose to make steel rails to British specifications? Why, I will undertake to eat every pound of steel rail they succeed in making."

That was the scornful remark that was reportedly made to Charles Page Perin, the American consultant to the fledgling Indian steel company, by Sir Frederick Upcott, the then Chief Commissioner for the Indian Railways. Contradicting the scepticism, the infant Tata Steel succeeded admirably in making steel rails that were acceptable to the Indian Railways. It also exported 1500 tonnes of the material to Mesopotamia to support the Allied campaign there during World War 1. Dorabji Tata, the company's first Chairman, commented dryly that if Sir Frederick had carried out his undertaking, he would have had "some slight indigestion".



Surface inspection of rails at the new Rail Finishing Mill

Dr. Andrew McWilliam

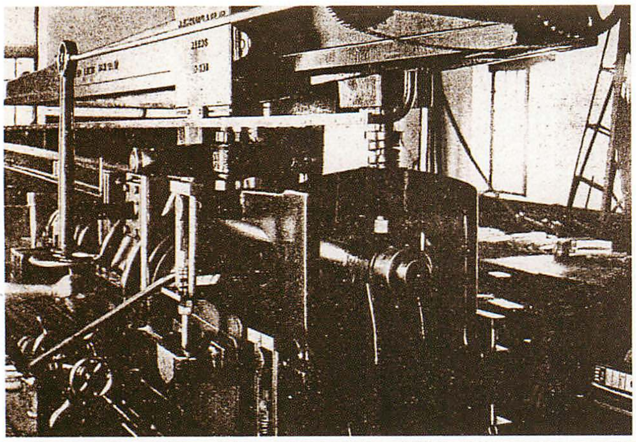
Tata Steel owed its success in producing rails, not only to the efforts of its own staff but also the valuable assistance and cooperation of Dr. Andrew McWilliam, D. Met., a renowned professor of Sheffield University. He was engaged through the India Office on a five year contract to the Railway Board, to serve as the Metallurgical Inspector at a proposed government testing laboratory located next to the steelworks.

After the construction of the laboratory, Dr. McWilliam started work at the Inspectorate when the first rail-heat was tapped out Tata Steel in February 1912. At that time, only one open hearth was running. Second furnace was added in September 1912. The first batch of rails produced by the company and passed by the Inspectorate was of 41 1/4 pounds section on an order from the Baroda State Railway. Dr. McWilliam grew very fond of Tata Steel and after the expiry of his term of office under the Government in 1918, he stayed on as a Technical Adviser to the company for another two years.

Dr. McWilliam whole-heartedly devoted himself to finding a solution for every knotty problem of steel making that was put before him. He used to be present in the works at all the stages to watch the making of heats and the rolling of steel. These rails were then cut to the required lengths in the hot saws, straightened and finished according to the specifications and then arranged in tiers for Government inspection in the yard. The Government Laboratory analysed one sample of every rail heat and one piece of every one hundred tonnes of rail.

After the rails had passed the walking and drop tests and completely analysed for their chemical composition, certificates were issued direct to the purchasers of materials from the Company. In the beginning, the charge used to be made on the tonnage of steel inspected, whether passed or rejected, to the railway for whom they were made. But, in a few years' time, at the instance of the railway companies, this procedure of debit on account of inspection of the rejected quantity was abolished by the Railway Board. This sudden change of procedure, however, did not affect the income of the Inspectorate since Tata Steel had by then a guaranteed order of 20,000 tons of rails to be supplied annually to the Railway Board for a period of 5 years at the outset.

The reputation of Tata Steel for the production of sound rail steel in India had already been established when the First World War broke out in August 1914.



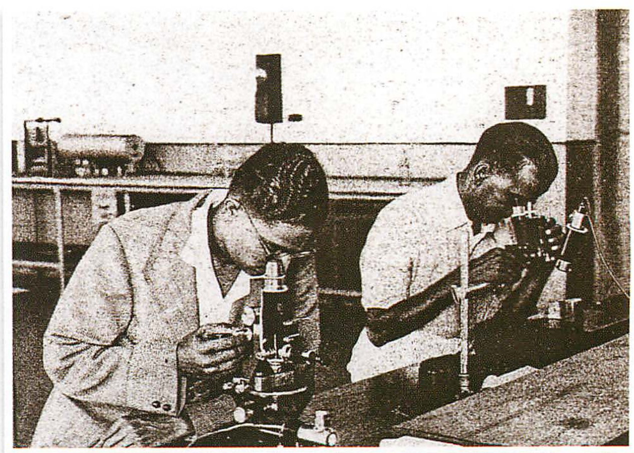
100 ton horizontal multiple lever Bucton Tensile Testing Machine at the Physical Laboratory

By then, the Company had completed a Bar Mill, increased the number of furnaces and erected a Physical Test House for tensile and other tests under the guidance of Dr. McWilliam. This could be regarded as the progenitor of in-house testing and research.

In the Bar Mill, Tata Steel had started making structural materials such as joists, bars, angles and channels of varied sections against Government and Railway orders. When the Great War broke out the company assumed great importance as it offered the only potential supply of iron and steel east of the Suez Canal. It was provided with huge orders for shell steel bar of different sizes and rails for the construction of military tracks.

The Company had only open hearth furnaces then and shell steel had never been made in such furnaces. Tata Steel did succeed in making the shells under the dogged and skilful command of its first General Manager, Temple W. Tutwiler, a veteran steelmaker from Gary, Indiana. The company did not have the means then to press the steel into shells. Tutwiler ransacked every railway and ship-building workshop that had a lathe to bore five-inch rounds into shells. They worked and saved the day in Mesopotamia for British and Indian troops. Not a single ton of Tata's shell steel was rejected. Special grades of steel for combat helmets and jerry cans were also developed and supplied.

The war effort took almost 80 per cent of the company's production. By the time the First World War was over, Tata Steel had already supplied 2,400 km of special Steel Rails and 3,00,000 tons of special grade steel for the manufacture of shells, combat helmets, jerry cans and other materials for Allied Forces for campaigns in Mesopotamia, Egypt, Salonica and East Africa.



Examination of structure of steel by Polarisation Microscope

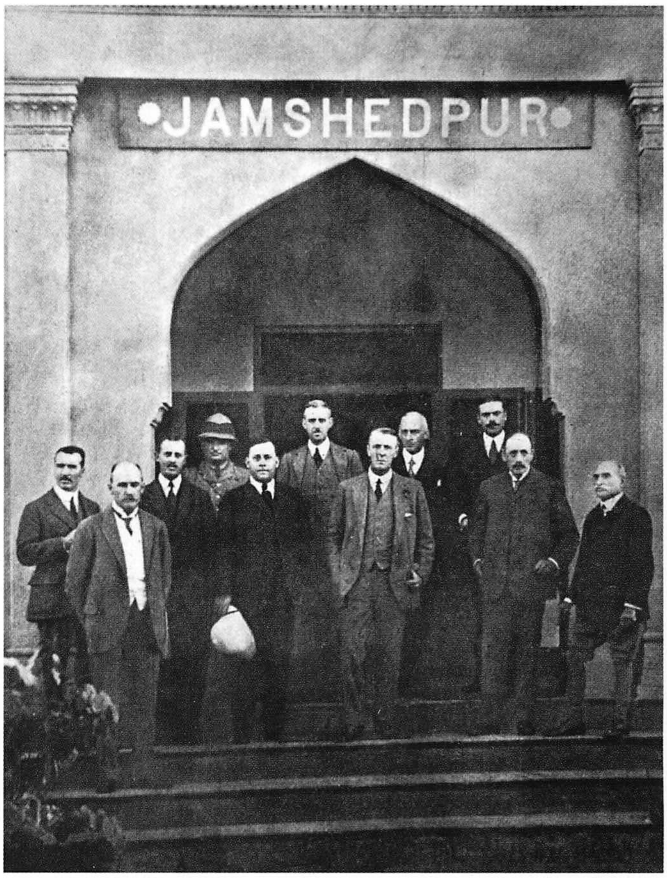
The extraordinary Mrs. McWilliam

There is an interesting aside to the dedication of Dr. McWilliam in helping Tata Steel in its infant years to achieve the required quality of rail steel. That is the role played by his wife as a true helpmeet or "ardhangini" (the other half) as the ideal Indian wife is called. In the beginning, the work in the Railway laboratory headed by Dr. McWilliam to inspect the rails from the neighbouring Tata steel works was conducted by the two chemists, Mr. Irwin and Mr. A.N.Bose. But when the company commissioned its second open hearth furnace in September 1912, the analytical work of the laboratory was greatly increased because of the frequent tapping of rail heats.

Dr. McWilliam had to often take the assistance of his wife in getting through the analysis in the laboratory. So, Mrs. William used to attend the laboratory regularly in the morning with her husband to help out in the analysis of the samples. Her work was quick and her results accurate. She made herself so indispensable that her husband had to call her to office even after lunch even in the hottest of days, when the mercury would cross 40 degrees Celsius. That was extraordinary for those colonial days when "memsahibs" spent most of the day under the room wide hand "punkah" pulled by one of the myriad servants. This went on for some time until the appointment of an engineer officer was sanctioned in 1914 to relieve Mr. Irwin to look after the analysis in the laboratory.

This contribution of Tata Steel was gratefully acknowledged by the Viceroy, Lord Chelmsford, when he came to visit the steel plant in 1919. It was on this historic occasion that the Viceroy announced the change in the name of the place of Tata Steel's factory from Sakchi to Jamshedpur, to identify it with the name of its founder, Jamsetji Tata.

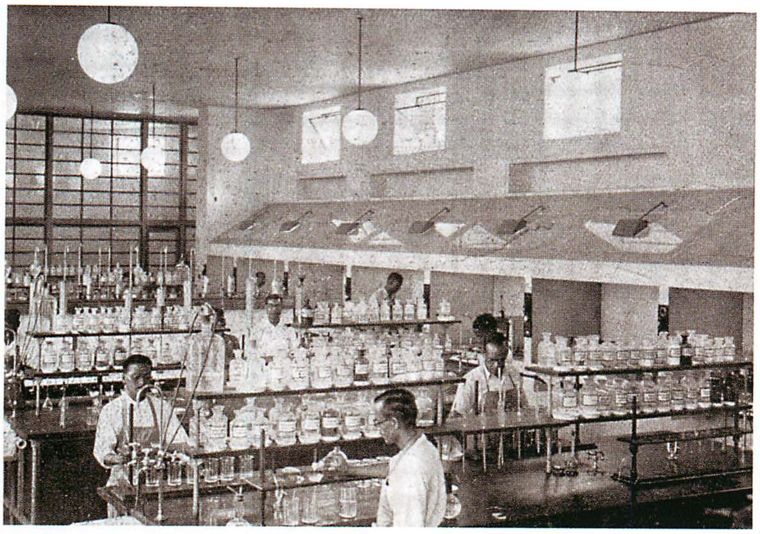
The term of Dr. McWilliam with the Government expired just before the Armistice was declared in November 1918. On his returning home he was awarded the C.B.E. But, as ill luck would have it, he did not live long to enjoy this distinction for he died soon after. But Tata Steel will be eternally grateful to him for the systems and procedures of work which he laid down, particularly in inspection and testing, which laid the foundation for research and development work in the Company.



The visit of H. E. the Viceroy Lord Chelmsford (2nd January, 1919)

"In the fullness of time, this laboratory should play an important part in the progress and development of the steel industry in India and the training of an efficient body of Indian research workers in the metallurgy of iron and steel."

Mr. A. R. Dalal, Director of Tata Sons,
during the laying of the foundation stone, 6 November 1935



Tata Chemical Laboratory (1939)

The great innovators of the Industrial Revolution almost single-handedly created entire industries out of their own imagination and scientific skills. Examples are Thomas Edison with the incandescent light bulb, Alexander Bell with telecommunications and Daimler with diesel engines.

The manufacturing companies that emerged soon realised that continuing innovation was the key to remain competitive. However, the increasing complexity of new technologies meant that innovation needed dedicated teams of scientists and engineers working together in an organised manner. This lead to the birth of industrial Research & Development (R&D).

One of the world's first such industrial R&D centres was created by Philips in the Netherlands, which as early as 1914 established a research laboratory to study physical and chemical phenomena and to stimulate product innovation.

Many companies in the western world adopted this new branch of business activity. General Electric, Daimler-Benz, Bosch, Siemens and many others established large dedicated R&D centres during the first few decades of the 20^{th} Century.

In India, Tata Steel has the distinction of being the first company to establish a composite and comprehensive corporate centre for R&D, back in 1937. This was a natural corollary to the vision of the founder, Jamsetji Tata, who foresaw an aspiring India with strong home-grown Industries, self-rule and self-reliance in technology.

Already in the late 19^{th} century, Jamsetji Tata resolutely pursued the founding of an institute of post-graduate research in India. A bold initiative that became the Indian Institute of Science, established in Bangalore in 1909.

Swami Vivekananda

Jamsetji had been encouraged in this initiative by Swami Vivekananda, the renowned monk who was a strong advocate of the use of science for advancement of the nation. The Swami is quoted to have said *"With the help of Western science set yourself* *to dig the earth and produce foodstuffs – not by means of mean servitude of others – but by discovering new avenues of production, by your own exertions aided by Western science."*

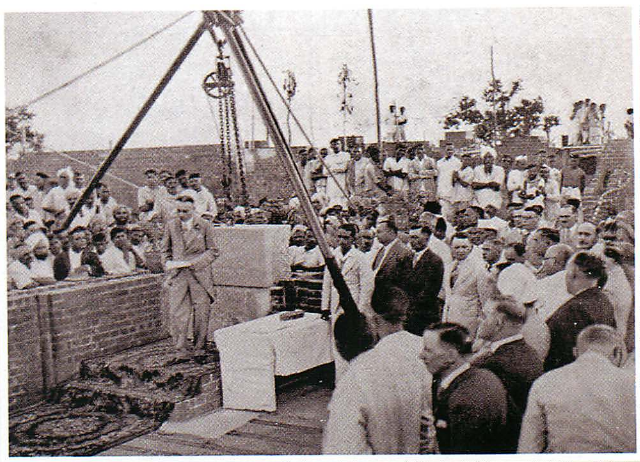
Another important founding father of R&D at Tata Steel was the eminent engineer-statesman from Mysore, Sir M. Visvesvaraya. He was a stalwart of the early years of Indian industrialisation and also a Director of Tata Steel. During a Board meeting in 1932 he pointed out that, within his experience, there was no large factory in Europe or America without provision for research. The chief object of such research was to reduce costs and increase output. Enormous sums were spent; in some cases one-tenth of the net profits of a company. Therefore, he strongly advocated that:

Sir M. Visvesvaraya

"There should be a Research Bureau maintained to carry on investigations into the methods of manufacture, costs reduction, fuel economy etc., so as to make some advance towards rationalisation. The engineers on the committee associated with research should collect material from technical journals, through foreign agents and in other ways, and constantly keep up the practice of comparing results under every phase of operation with those obtained on similar steel works abroad."

On 6th November 1935, Tata Steel saw the first physical demonstration of this vision shared by Jamsetji Tata, Swami Vivekanda and Sir Visvesvaraya. That day saw the laying of the foundation stone for Tata Steel's Control and Research Laboratory.

However, the building is popular today as Research and Control Lab and houses the R&D, Scientific Services and Refractory Technology Group (R&DSS).



Mr. A R Dalal delivering his speech on the occasion of the laying of the Foundation Stone of the R&D building (6 Nov, 1935)

The start of this Division in Tata Steel meant the very start of corporate R&D in all of India. It was a tell-tale sign of the enlightenment of the House of Tata to set up such a 'Western' concept in the then remote township of Jamshedpur.

This is illustrated in the address of Mr. A. R. Dalal, Director of Tata Sons, during the laying of the foundation stone:

"Great advances are being made in the world today in the processes of steel manufacture and no manufacturer who wishes to maintain his competitive position can afford to neglect this very important branch of his activities. In India we are labouring under a very special difficulty in this matter. No research institution on a national scale is possible in India at the present stage of development of its steel manufacture. As the only manufacturer of steel we have to provide for our own research."

On 14th September, 1937 the new research centre was formally opened by Sir Nowroji Saklatwala, then Chairman of the Tata Group.

It was designed by the firm Ballardie, Thompson & Mathews, leading architects at the time in conjunction with the Chief Metallurgist and Chief Chemist of the company. The building was constructed by the Hindustan Construction Company Ltd. With an elegant facade in the Art Deco style, it dominated the Jamshedpur landscape and made a grand statement to the trust in science and innovation. Even today this building remains a striking piece of architecture and can be classed amongst the most beautiful buildings in Jamshedpur.

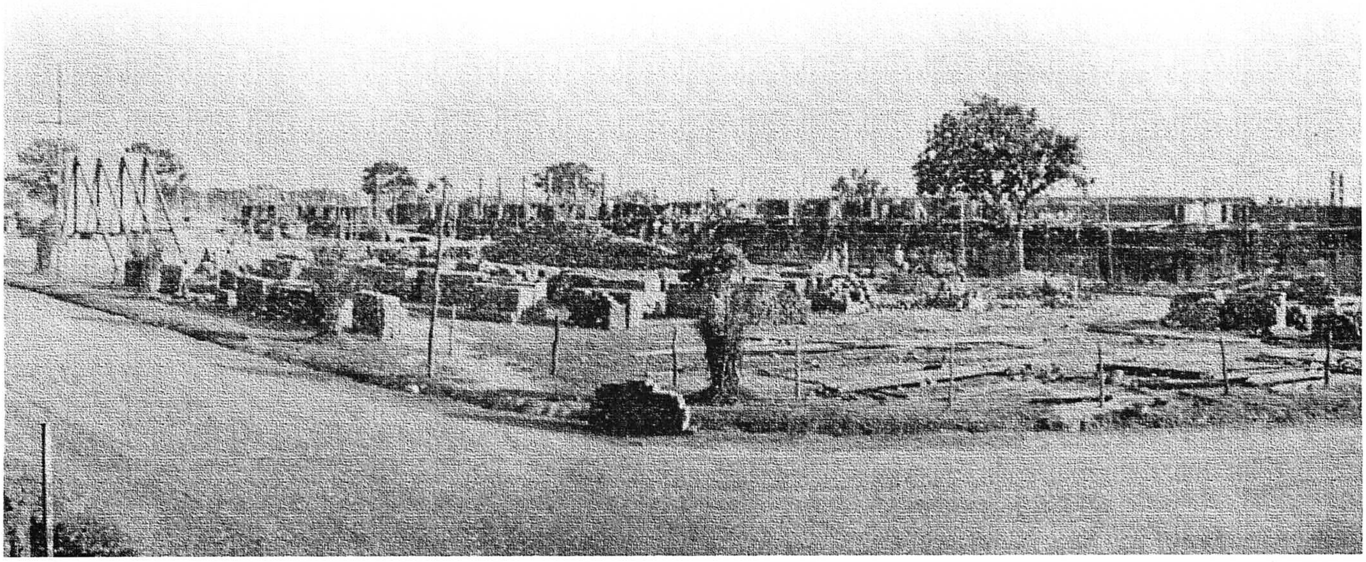
Around 400 tonnes of steel, 3000 tonnes of cement and 5 million bricks went into its construction. The estimated total cost was Rs 9 lakhs, a huge amount in those days. Still today it is colloquially known in Jamshedpur as the *"Nau Lakhi"* building.

The new Control and Research Laboratory was designed to deal with matters relating to research work in addition to routine work under the following heads:

1. Control of raw materials, involving analytical and chemical problems, for purposes of selection or investigation.
2. The study, observation and supervision of all metallurgical operations carried out within the steel plant.
3. The properties of special irons and steels.
4. Refractory materials.
5. Corrosion problems.
6. Development of new steels and new products of all kinds.
7. Fuel laboratory.

It was built on three sides of a square of 335 feet. The central entrance leads to a waiting hall with a large domed ceiling that is topped by an 80 feet high tower. The central Administrative Block contained offices, a Conference Room and a large Technical Library along the main corridor with easy access from all sides.

There were three main sections in the research centre Metallurgy, Chemistry and Refractories. The Metallurgical Section was provided with rooms and equipments for mechanical testing, heat treatment, physical and corrosion testing, dark rooms for metallography, etc. The Chemical section had facilities for wet analysis, gas analysis, colorimetry, electro-chemistry and specimen preparation rooms. The Refractory section, occupying 6,000 square feet, had dust-proof pulverising rooms, furnaces for



A view of the new Control and Research Laboratory at Jamshedpur under construction

Scientific Services today

Sampling, testing and analysis are the essential activities for steelmaking production control, quality assurance and research & development. Facilities for these activities were installed during the early founding days of Tata Steel. These included laboratories for chemical analysis and physical characterisation of raw materials (coal, iron ore, fluxes, etc.), intermediate products (agglomerates, iron and steel chemistry), by-products (slag, gases), supporting materials (refractories, plant components), fuels and finished steel products.

During the early years, these activities and facilities were distributed amongst the various production units as per the need for proximity. In 1937, when the company established its main Control and Research Laboratory, these analytical services were centralised. In the course of time, the activities of the central laboratory were bifurcated into two separate departments for Research & Development (R&D) and Scientific Services (SS) under the central leadership of the Chief R&D and Scientific Services.

The activities of the early Scientific Services department primarily involved ceramics and refractories, chemistry, metallurgical services and quality assurance. Metallurgical services included a host of responsibilities such as process and quality control at various production centres as well as analytical work in the Metallography Laboratory and Physical Laboratory.

Following a company-wide reorganisation in 2001, the process and quality control responsibility was taken out of the purview of Metallurgical Services and placed with the manufacturing units. However, the responsibility for accurate and timely analyses to support process and quality control remained. In addition, the R&D and SS departments merged and the Refractory Technology Group was added to form the R&D and SS Division. This centralised all laboratories into a single division for the effective management of these facilities and their associated know-how.

The R&D and Scientific Services departments are individually ISO certified for quality assurance and all laboratories under Scientific Services are NABL accredited units for stipulated metallurgical, mechanical and chemical tests.

The Scientific Services department consists of four Chemical Laboratories, a Physical Laboratory, a Metallography Laboratory, a Plant Metallurgical Inspection Group and Central Raw Material Testing Laboratory. It also provides various facility management services to the R&D and Scientific Services Division.

The department operates in close collaboration with the production plants. It generates and analyses product quality data for raw materials, chemical analysis for process control, mechanical properties for certain product certifications and also conducts failure investigations related to plant components and customer complaints. Many of these activities are conducted around the clock.

The laboratory is also involved in various improvement projects for life enhancement of engineering components, process and product improvements. Each year the officers of the Scientific Services department conduct approximately 20 such improvement projects and thereby develop and demonstrate their progress in solving difficult plant problems.

Today the Scientific Services department has a payroll of 264 persons, amongst these are 44 officers.

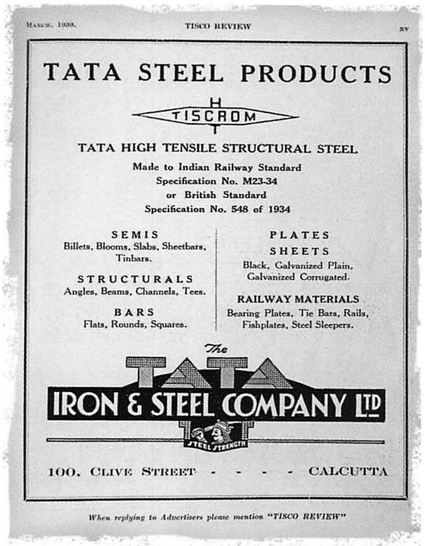
spalling, fusion, load and slag tests, a brick making room, electric furnaces and a special microscope room.

The building was designed to offer efficiency, comfort and flexibility. Rooms were laid out to provide a straight line flow of work and were connected by wide corridors. The working tables and benches were designed and constructed to be easily dismantled, added to or modified, with detachable cupboards and drawers. All services, including gas, water, power and vacuum were supplied through a duct running below the floor so that maintenance access was easy and the walls were kept free of piping and cabling.

Special attention was paid to safe and healthy working conditions, with considerable thought given to ergonomics, lighting and ventilation. The positions and heights of the tables and benches were designed for convenience of the technicians and to avoid unnecessary movement of the workers. Fume extraction systems were installed with specially designed hoods to protect the technicians. Switchboards were kept out of the laboratories and installed in the corridors to avoid corrosion due to fumes in the chemical labs. Numerous emergency showers were provided in case of acid splashes or similar incidents.

The building was planned to meet the research requirements of the steel company for at least the next 20 years. That it still accommodates the enhanced R&D requirements of the company, 75 years later, is a testimony to the far-sightedness of the designers and builders of its designers.

The silvery steel lattice of the Howrah Bridge towers over the Hooghly River in Kolkata. It is recognised world over as the symbol of this Indian metropolis. Not many people know that in the early 1940's Tata Steel supplied most of its 26,500 tonnes of steel.



Producing steel for the Howrah Bridge was a major challenge to Tata Steel, since it had not yet ventured into low alloy structural steels. The specifications of the steel to be used called for a tensile strength of 37 to 43 tons per square inch. Developing this grade became the major focus of its new in-house research centre, that was opened just a few years ago.

At the time, an Electric Arc Furnace and a 0.5 tonne High Frequency Induction Furnace were just installed in the steel melting shop and were used to produce the alloy steel. In the beginning, certain difficulties were experienced in the rolling of sections. The degree of spread in this steel under the rolls was found to be different from that of plain carbon steel. Engineers had to modify the pass designs to enable it to roll sections in special alloy steel as well as plain carbon steel on the same roll setting.

Another difficulty was the removal of the tightly adhering oxide scale that formed due to the alloying elements used. This was addressed by introducing high pressure water on every pass to break off the scale. The presence of copper, to enhance corrosion resistance, also caused a peculiar problem of surface cracking. Ultimately, the researchers and engineers of Tata Steel were able to overcome all these challenges and the new steel product they created was christened 'Tiscrom'.

However, before this steel could be accepted by the Howrah Bridge construction engineers, Tata Steel needed to contest patent suit that tried to uphold the need to use imported high tensile steel. A great deal of public opinion was aroused in favour of the indigenously developed Tiscrom and the suit was finally decided in favour of Tata Steel. The success of building the Howrah Bridge with Tiscrom enabled the winning of contracts as far away as Burma, where the same material was used to build the bridge over the Irrawady and to lay the pipe lines near Rangoon.

Tiscrom and other early types of high tensile steel were quarternary steels with alloy additions of chromium, manganese and copper. They were not amenable to welding, since the heat generated by welding tended to produce brittle zones adjacent to the weld. This is the reason why today Howrah Bridge stands out as a totally riveted structure.

Tata Steel's researchers therefore also started developing a high strength structural steel that was amenable to welding. They came up with 'Tiscor', a quinary steel containing chromium, copper, silicon and phosphorus. Carbon conveys the greatest degree of hardenability in steel. This element was therefore maintained at a very low level for good weldability, while the higher yield strength was obtained through a balanced combination of the aforementioned alloying elements.

Tiscor's high yield strength enabled its use in thinner sections, while its weldability promoted its use in freight cars, ships, trams, and various other vehicles. Tiscor was also found to be more corrosion resistant than plain carbon structural steel.