A STUDY ON REQUIREMENT AND AVAILABILITY OF TECHNICAL MANPOWER FOR STEEL INDUSTRY IN INDIA

Indian Institute of Technology, Kanpur

May 2015

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Preface

Steel plays a vital role in the development of any modern economy. "Per capita consumption of steel" is generally accepted as a yardstick of socio-economic development and living standards of people. As such, no developing country can afford to ignore steel as the latter, owing to its strategic importance in development. Steel has diverse applications but is predominantly used as structural materials. Nearly 60% of steel produced in India is currently used in construction and remaining as automotive material, capital goods, consumer durables, packaging material and so on. Current level of steel production in the country is about 81 MTPA, projecting a dismal figure for per capita steel consumption[1]. Therefore, as India moves ahead to become a developed nation, steel, which is essential for infra structure development (along with cement and electricity), must be available in large quantity. This necessitates setting up of new energy and emission efficient steel plants, capacity enhancement of existing mills, adoption of new technology and removal of obsolesce from existing plants and so on. From a meagre 2 MT of crude steel produced in the country during 1950-51, nearly 81.69 MMT of crude steel was produced in 2014. This is expected to increase further, reaching a figure of about 300 MTPA by the year 2025. India is poised to emerge, by 2016 , as the second largest steel producer in the world[2]. Parallel to such, it is imperative that high quality technical manpower is available in the country to manage and run our steel mills as efficiently as possible. Therefore, in the changing scenario of steel production in the country, it is important to take stock of the prevailing situation as far requirement and availability of technical manpower for domestic steel and allied sectors are concerned.

Consequently the purpose of the present study has been to make an assessment of requirement and availability of technical manpower at different skill sets needed to manage and sustain crude steel production of 300 MTPA by 2025. To this end, steel and allied industries in the country were contacted to provide manpower and production related figures, which formed the basis of the present study. Spontaneous and enthusiastic supports, followed from a large number of industries, throughout the course of the present investigation,.

In undertaking the study we have been immensely helped by various organisations in the country, in particular, The Ministry of Steel, The Ministry of labour, The Indian Institute of Metals (Kolkata), INSDAG (Kolkata), IRMA (Kolkata), SIMA (New Delhi), NISST (Govindgarh) and AICTE. We gratefully acknowledge their assistance towards fruitions of the present work. Finally, we sincerely hope the estimates provided and directions indicated in this report come handy in making future plans as far as issues related to skilled technical manpower for domestic steel industry is concerned.

May 31st, 2015
Kanpur

Dipak Mazumdar and Indranil Manna

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[1] A 2010-11 estimates of per capita steel consumption is: South Korea (1077 kg), Germany (440 kg), China (427 kg), USA (258 kg), Russia (256 kg) and India (51 kg). The world average is about 202 Kg. It is estimated that in many villages in India per capital steel consumption is as low as 2 kg.

[2] India's real consumption of total finished steel in 2011-12 was 70.92 Million Tonnes. This represents a growth of 8.7% during 11th Plan. India remains the largest producer of sponge iron (DRI), emerged as the fourth largest steel producer and the third largest finished steel consumer in the world during the 11th Plan period (2007-2012).

Executive summary

The present study on the requirement and availability of technical manpower for domestic steel industry was carried out separately, on two distinct parts i.e., requirement and availability, at IIT Kanpur as well as at IIM head quarter at Kolkata. While the task of estimating requirement was carried out at IIT Kanpur, the same for availability was carried out at IIM, Kolkata. The exercise was initiated by framing a set of appropriate questionnaires for various industries and educational institutes in the country through an eleven member expert committee who met at IIT Kanpur during August 2014 to formulate and finalize the questionnaires. Feedback from industries and educational institutes as well as vital inputs obtained from INSDAG, SIMA and IRMA formed the basis of quantifying requirement and availability of technical manpower. On the basis of such, gap between the two, if any, was identified at each skill set as well for each individual stream/discipline.

Following a brief introduction and a review of the previous work summarised in Chapter 1, requirements of technical manpower for steel and allied industries under different skill set is addressed in detail in Chapter 2. Towards estimating the requirement, 240 industries from nine different sectors including, steel producers (primary and secondary both) and allied industries (e.g., Merchant pig iron, Sponge iron, Ferroalloy, Rolling mill, Pelletisation etc.) were contacted and about 149 of these visited by the committee members and their associates. Data on productivity and the associated technical manpower (ITI trained personnel, Diploma engineers, graduate and post graduate engineers including doctorates) were obtained from 186 different industries and based on such, numbers of engineers required to produce a thousand ton product for each sector was determined. Since total annual productivity for each sector for the year 2014[3] is known, consequently, embodying the "engineers per thousand tonne of product", total technical manpower currently associated with each sector has been estimated. This indicated that an overwhelming majority (almost 80%) of the engineers are associated with the steel plants (primary and secondary producers combined) while remaining 20%, with the allied industries. Furthermore, of the total technical manpower associated with steel plants and allied sector industries, nearly 62% are associated with the primary steel producers alone! Based on feedback and subsequent rationalisation, stream-wise (Metallurgical, Mechanical etc.) number of engineers employed presently in all nine sectors (including steel plants and allied industries) have also been simultaneously estimated. Given the current level of crude steel production (~81MMT) in the country, the number of graduate engineers required to produce 240[4] tonne of liquid steel annually can be conveniently estimated through straightforward extrapolation. The number thus obtained can be further enhanced by 20% to accommodate employment in the allied sector in the ambit of present calculations. Subsequently, considering current employment as well as

[3] INSDAG, Kolkata

[4] One estimate available with INSDAG, Kolkata indicates that of the 300 MMT steel produced in 2025, nearly 240 million tonnes would be in the integrated sector and 60 million tonnes, in the secondary sector.

superannuation of a part of the present task force, a modified and more realistic estimate has been derived. The value thus obtained represents the number of graduate engineers required over a period of next ten year (2015-2025) in steelmaking and allied industries and correspond to the upper bound as possible modernisation and automation of steel industries could reduce such estimates drastically. Towards this, a lower bound on requirement has also been worked out embodying manpower and productivity related data from modern steel mills in advanced countries. It was assumed that future steelmaking industries in India would be at least at par with the present day Japanese steel industries. Following a similar approach, estimates of diploma engineers and their stream wise requirements as well as requirements of ITI certificate holders were made for the next ten years. Required number of graduate engineers, diploma engineers and ITI trained personnel were also normalised to present corresponding requirements per year, per million tonne of steel. Research and Development in steel plants and associated requirements of highly qualified technical personnel was also given adequate attention, under a separate heading, in Chapter 2

Parallel to the above availability of graduate and diploma engineers as well as ITI certificate holders were made by consulting a large number of institutions/ universities, AICTE and the Ministry of Labour and Employment and this is summarized and discussed elaborately in Chapter 3. The available numbers obtained from different sources were rationalised on the basis of the input that all graduate engineers are not keen to join the steel industries. A comparison of requirement with the effective available number of engineers (deduced by considering suitable employability factor) indicate distinct gaps between supply and demand exist as far as metallurgical (graduate and diploma engineers) and ceramic engineers (only graduate engineers) is concerned. Such findings from the present study are essentially identical to that of the previous study (the 2007 study), though arrived at following distinctly different approaches. Finally, the current scenario of engineering education and employment in the country, particularly with reference to metallurgical engineering discipline and steel industries, were critically examined by experts in a workshop. Recommendations made by the committee for reversal of existing trends are the discussed in Chapter 4 of the report in detail.

1

Overview

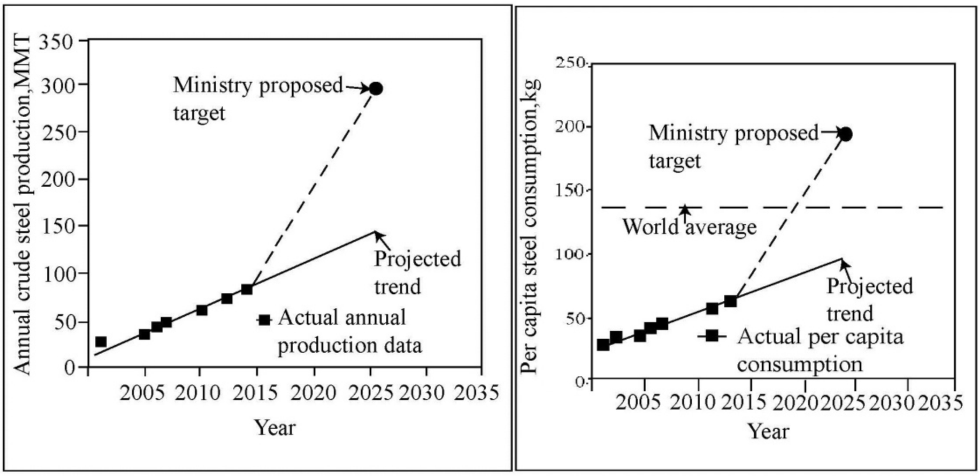
1.1 Introduction

Steel plays a vital role in the development of any modern economy. “Per capita consumption of steel” is generally accepted as a yardstick of socio-economic development and living standards of people. No wonder, crude steel production in the world, since the beginning of last century, has been increasing steadily touching the 1.5 Billion Metric Tonne mark in 2014! As such, no developing country can afford to ignore steel owing to its strategic importance in development. The world crude steel output grew steadily during the period 1940-1980 due to the growth of steel consumption in US, erstwhile USSR, Japan and other developed countries in Europe. However, the growth rate slumped for the next 15 years up to 1995 due to the world wide recession. It has been estimated by the International Iron and Steel Institute (IISI) that world crude steel production could reach 2000 Billion Metric Tonne by the year 2020!

Steel has diverse applications but is predominantly used as structural materials. Nearly 60% of steel produced in India is currently used in construction and remaining as automotive material, capital goods, consumer durables, packaging material and so on. Current level of steel production in the country is about 81 Million Metric tonnes, projecting a dismal figure for per capita steel consumption. Therefore, as India moves ahead to become a developed nation, steel, which is essential for infra structure development (along with cement and electricity), must be available in large quantity. This necessitates setting up of new energy and emission efficient steel plants, capacity enhancement of existing mills, adoption of new technology and removal of obsolesce from existing plants and so on.

From a meagre 2 MMT of crude steel produced in the country during 1950-51, nearly 81 MMT of finished steel was produced in 2014. According to the Ministry of Steel, Govt. of India, this is expected to increase further, reaching a figure of about 300 MMTPA by the year 2025, to correspond to about 200 kg per capita steel consumption, that is well above the current global average! India is poised to emerge, by 2016 as the second largest steel producer in the world. The growth in steel production in India and corresponding per capita steel consumption for the past decade are shown in Figs. 1.1(a) and 1(b) respectively. There, projections by the Ministry of Steel, Govt. of India for immediate future years have also been included. As projected, India has a very high potential for growth in per capita consumption of steel when compared to BRIC countries which are having very high economic growth and USA, a highly developed country. Figure 1.1 also shows a steady and moderate rise in production during the last fifteen years. However, beyond 2015-16 and up to 2025, the projection given by the Ministry of Steel Govt. of India shows step rise in crude steel production. Needless to mention, a completely overhauled strategy, in terms of land, material, energy, technology and manpower shall be needed to accomplish the Ministry specified desired target!

Given the target of 300MT of steel by 2025, it is anticipated that there will be enormous demand for technical manpower to run and manage steel industries competitively. The scarcity of trained technical manpower, particularly graduate and diploma engineers in Metallurgical and Ceramic Engineering, as the 2007 report indicated[5], may pose a stiff challenge to the proposed growth of steel industry. Immediately after independence, during 1950s and 1960s, high industrial growth in the country attracted a large number of geologists, mining engineers, metallurgists, chemical, mechanical and civil engineers to the steel plants. Almost simultaneously, number of academic institutes grew up. However, between 1975 and 2000, manufacturing industries, in general, and iron and steel industry in particular, experienced successive ups and downs and as a consequence, the priorities of the educational institutes, old as well as new, changed and their academic curricula were re-oriented to suit the needs of non-manufacturing sectors, emphasizing such subjects as Computer Science, Information Technology, Electronics, Telecommunication, Nanotechnology etc.



(a) (b)

Figure 1.1 (a) Annual steel production figures including the proposed target and (b) Per capita steel consumption in the country during the last ten years and future projection.

It is heartening to note that situation is changing and greater emphasis on manufacturing is being laid again, particularly with respect to the iron and steel industry. The challenge to accomplish the 2025 target is manifold and includes several complex issues such land acquisition, material and energy supply, availability of bright engineering graduates and diploma holders to run future steel mills

[5] A study on technical manpower in steel industry: requirement and availability (2007-2012), IIM Kolkata.

efficiently. These are some of the major concerns, linked intricately to the future growth of the steel industry in the country, for the entrepreneurs as well as the Ministry of Steel, Govt. of India alike.

Beyond land, material and energy, requirement and availability of technical manpower to run future steel mills and thus fulfil the mandate of 300 MMT by 2025, is an equally important issue. An assessment of the latter, at the behest of the Ministry of Steel, Govt. of India was undertaken in 2007 by an expert committee commissioned by the Indian Institute of Metals, Kolkata. Since the time the work was completed, many new developments have taken place. On the industrial front, ambitious capacity enhancements have been announced as well as new technology and large scale automation being contemplated. In the field of education, several new institutions have come up and capacity of existing institutes increased significantly. These necessitate that the 2007 report be re-visited and revised estimates of requirement and availability of technical manpower made considering the changed scenario. To this end, a new and revised target viz., 300 Million tonnes of steel by 2025 was set by the Ministry of Steel. The latter also proposed that IIT Kanpur takes up the aforesaid study by constituting an expert group/team.

Consequently, the purpose of the present work is to collect pertinent data from steel (both primary and secondary producers) and allied industries (including plants dealing with sponge iron, merchant pig iron, rolling mills, ferroalloys, refractory, pellets etc.) as well as from educational institutes across the country and analysing the same as rigorously as possible to quantify technical manpower requirement and availability for domestic steel and allied industries with reference to a target production of 300 Million tonnes by 2025. The study attempts to take stock of the current manpower situation, extrapolate rationally and suggests measures to provide suitable technically qualified manpower for efficient management of the domestic steel industry.

1.2 Previous work

In 2007, Indian Institute of Metals completed a study for Ministry of Steel, Govt. of India, on the requirement and availability of technical manpower for steel producing sector including sponge iron and pig iron plants. The said study, on the basis of data obtained from various sources (viz., production units, the Ministry of Steel, JPC, Design, consultancy and R&D institutions, AICTE, media, web and published literature) projected an annual steel production in the range of 214 to 297 Million tonnes by 2020. The study also predicted significant gap between requirement and availability for Metallurgical and Ceramic engineering disciplines, both at the diploma and degree level. A brief account of the previous study is summarised below.

To accomplish the objectives and execute the task commissioned by the Ministry of Steel at the Indian Institute of Metals, a five member core committee from industry, research, design, and academic institutions was constituted. Furthermore, to assist the core team in organizing and conducting the study, a project team comprising of five other members was formed. As a starting point, data formats specific to each of the six sectors were formulated and these were sent to one hundred and thirty five different organisations including, (i) Blast Furnace/Corex-BOF steel plants (ii) Electric Arc Furnace units (iii) Induction Furnace units (iv)Sponge iron units (v) Pig iron plants and (vi)Support services organisations. Altogether eighty organisations responded to the questionnaire and these, together with the data collected directly from plant visits, constituted the basis of calculation, analysis and interpretation.

Table 1.1: Steel production/capacity in India during 2007-2020 as envisaged in the previous work (the 2007 study).

Year	Production/Capacity (Million Tonne)		
	Brownfield	Greenfield	Total
2006-07	55.5	Nil	55.5
2011-12	96.0	42.5	138.5
2015-16	114.3	107.5	221.8
2019-20	132.1	165.8	297.9

Data were collected from various existing and proposed plants in the country, the Ministry of Steel, JPC and this indicated accelerated growth of steel production in the country as shown in Table 1.1. The figures shown in the foregone table were deduced on the basis of feedback which indicated that if all green field and brown field projects materialise, by 2020 India would be producing nearly 300 Million tonnes of steel. Technical manpower estimates were made for such a target considering two different options viz.,

(i) The optimistic option: 100% of brown field and green projects implemented and
(ii) The conservative option : 100% of brown field and 50% of green field projects implemented

The projected trends of steel production in the country made in 2007 considering the figures presented in Table 1.1 and the two options mentioned above are shown Fig.1.2. There, as seen, projected estimates reflect significantly higher growth rate for steel production in the country during 2007-2020 via either options. Interestingly, the current level of steel production is much lower (also included in the figure); the 2014 production figure standing at 81 Million tonnes! Sluggish economy coupled with low GDP growth rate, land and mines issues etc. combined seem to have derailed the previous estimates completely.

Incorporating experiences from the industry and considering the following proportion of sponge iron in the steelmaking charge mix viz., EAF:50%, EIF:60% and BOF: 3%, corresponding estimated demand for sponge iron during the period 2011-2020 were derived. This is shown in Table 1.2. Analogous to the steelmaking trends (i.e., Fig.1.2), production of sponge iron was also predicted to follow a high growth rate path. None the less, sponge iron production, like steel production did not grow expectedly. It is important to mention that in 2014 nearly 22 Million tonnes of sponge iron was produced which is substantially smaller than the envisaged quantity shown in

Table 1.2. For the Pig iron sector, it was assumed that primary and secondary producers, shall in combination, yield about 9 Million tonnes of pig iron annually.

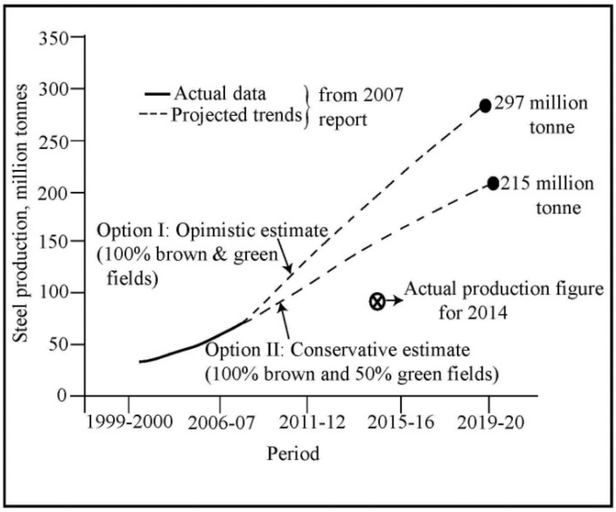


Figure 1.2 Envisaged growth of steelmaking capacity in India during the period 2007-2020 considering the optimistic and conservative approximations [ref. 2007 report].

Table I.2: Sponge iron production/capacity in India between 2011-2020 as envisaged in the previous work [ref.2007 study].

Steelmaking process	Steelmaking capacity (Million Tonnes)			Demand for sponge iron (Million Tonnes)		
	2011-12	2015-16	2019-20	2011-12	2015-16	2019-20
EAF	26.1	33.13	42.13	13.05	16.56	21.1
IF	16.5	17.5	18.5	9.9	10.5	11.1
BOF	95.9	171.2	237.3	2.88	5.14	7.12
Total	138.5	221.83	297.9	25.83	32.2	39.32

Given the future productivity target and the associated technical manpower per million tonne of steel (obtained through feedback), the total manpower requirement for steel industries for each skill set (Graduate and diploma engineers, ITI certificate holders and B.Sc. /M.Sc.) was estimated in the earlier study. These has been further modified and made more realistic considering the following relevant issues:

(i) Brown field steel plants were considered to be more human intensive than green field plants. Towards this, actual plant productivity and manpower data were applied to estimate respective manpower per Million Tonne of steel.
(ii) Negligible superannuation was assumed for green field plants and
(iii) A yearly uniform 3% attrition till 2020 was assumed for the brown field plants.

The study concluded that by 2020, net additional technical manpower requirement for steel plants alone shall be to the tune of 175467 under the optimistic option and 121497 under the conservative options. On the basis of such, discipline-wise requirements were also estimated for each skill set viz., graduate and diploma engineers, ITI certificate holders as well as BSc./M.Sc. To this end, data provided by industries for each discipline (for example, proportion of metallurgical engineers per million tonne currently in the task force) was embodied to deduce the corresponding requirement for the given future capacity). In this way, requirements of technical manpower for each skill set were obtained for different disciplines. Practically the same methodology was used to infer the numbers (discipline wise at all skill sets) for the support services organisations (R&D laboratories and design organisations), sponge iron and pig iron plants. The analysis revealed many interesting aspects of technical manpower in the steel, allied and support service organisations. For example while support sector organisations are run and managed predominantly by engineers, the EIF based plants, pig iron and sponge iron units are dominated by diploma holders and ITI trained personnel. Furthermore ratio of graduate engineers to diploma holders between Corex-BOF vs. EAF plants was found to be close to unity. The study predicted that by 2020, support sector organisations, sponge iron units and pig iron plants shall require technical manpower to the tune of 5164, 35467 and 4590 respectively.

Parallel to the above, an extensive exercise was undertaken to assess the availability of graduate engineers, diploma holders and ITI trained personnel across the country through interactions with engineering institutions, polytechnics as well as industrial training institutes. Publications of AICTE (All India Council of Technical Education) were consulted in details for compiling necessary information. In addition through interaction with the Directorate of Employment and Training, useful information on ITI trained personnel was obtained. On the basis of such, discipline wise (Mechanical, Electrical, metallurgical etc.) availability of technical manpower for different skill set (engineers and diploma holders) were obtained. Similarly, number of yearly pass outs from different ITI's across the country was also estimated. The analysis indicated that during the period 2002-2012, number of Engineering institutes have grown remarkably and so as their intakes. In 2002 while nearly 2.5 lakhs of students were enrolled in undergraduate (B.Tech./B.E./B.Sc.(Engg.)) engineering programs, the same number grew almost 2.5 times touching a figure of 6.3 lakhs in 2012. It is important to mention that intake did not grow uniformly across all disciplines; certain specific disciplines, such as, IT, CSE, Mechanical Engineering etc. were the primary beneficiaries. On the basis of placement records obtained from various institutes it was further assumed that of the total number of students graduating per year, nearly 1.25% from CSE and IT and 6.25% from other disciplines are generally available for the iron and steel industry. Similarly, it was found out from AICTE sources that nearly 1,30,000 students were admitted on a yearly basis to different polytechnics across the country and 25% of these would be typically available for the iron and steel industry. It was also found out that nearly 671941 seats are available annually in Industrial Training Institutes and about 5% of the sanctioned strength (~33,000) shall be generally available to serve the domestic steel industry.

Based on the estimates of requirement and availability, it was shown that there exist gap (requirement > availability) as far as graduate engineers are concerned in the discipline of Metallurgical and Ceramic Engineering. For Metallurgical engineering graduates while the yearly gap is significant (between 200 and 400) the same is less pronounced for the discipline of ceramic engineering (between 60 and 90). While only marginal gap for metallurgical engineering diploma holders was predicted, no shortage for ITI trained personnel was envisaged for all years.

1.3 Scope of the present work

As reflected from the review and analysis summarised in the preceding section, it is evident that steel production since 2007 did not grow in the country at the envisaged rate. Despite such there is indication by 2015-2016 India is poised to emerge as the second largest Steel producer in the world and according to the Ministry of Steel press release, expected to touch a production of figure of nearly 300 Million tonnes by the year 2025. The figure is presumably arrived from the corresponding per capita steel consumption of nearly 200 Kg, which is equivalent or marginally higher than the current global average. It is also estimated that of the 300 Million tonnes of steel likely to be produced by 2025, nearly 240 Million shall be produced by the integrated sector and 40 Million Tonnes by the secondary sector, including EAF based alloy steel plants. Considerable parallel expansion in the production of sponge iron, hot rolled coils and slabs, pig iron, ferroalloys, pellets etc. are also naturally anticipated. The support service organisations are also expected to grow considerably over the next decade, particularly if India has to emerge as a globally competitive and innovative steel producing nation. In such context, not only the number of graduate engineers but also that of diploma holders and ITI trained personnel matters. This is so as manufacturing sectors such as rolling mills, sponge iron units, pelletisation plants etc., that are connected intricately to the steel plants tend to rely heavily on diploma holders and ITI trained personnel to manage such units.

During the last few years, many new educational institutes have come up in the country but only a handful of these appear to have undergraduate metallurgical engineering education program. Furthermore, more and more metallurgical engineering department are re-orienting their curricula towards materials rather than traditional metallurgy and that is of concern to the iron and steel and the allied manufacturing sectors. Given that 2007 report had predicted a shortfall of metallurgical engineering graduates and diploma holders, the above mentioned issues become naturally a matter of concern particularly for the sustenance and growth of the iron and steel industries in the country. Looked at from stand points, it is worthwhile to re-visit the earlier study and make a fresh assessment of the subject of technical manpower requirement and availability for the future steel industry in the country.

1.4 The layout

The present study was launched at IIT Kanpur on the 1st of August, 2014. The first combined meeting of the core and project committee was held in the institute during August 18th and 19th (see Fig.3) during which, questionnaires were developed for 10 different sectors connected directly and indirectly with the management of iron and steel industries in the country. A set of questionnaire was also framed for the educational institutes to seek data on intake, number of pass outs and number of graduates/diploma holders taking up jobs with steel and allied industries.

Based on the feedback obtained from industries, laboratories and educational institutes, an in-depth analysis was carried out to quantify technical manpower requirement and availability at all relevant skill sets. Details of data collected from industry and their consequent analysis, including some international benchmarking, applied to quantify requirement of technical manpower have been elaborated in Chapter 2. Similarly, data from educational institutes and the corresponding numbers of available graduate and diploma engineers as well as ITI trained personnel are presented in Chapter 3. Chapter 4 presents a consolidation of the two earlier chapters. Based on the results and discussion presented in Chapters 2 and 3 as well as an extensive brain storming exercise carried out at IIT Kanpur on April 13th, 2015, a set of recommendations have been made and these are also summarised at the end in Chapter 4 of the report.

2

Requirement of technical manpower

2.1 Introduction

To study the requirement and availability of technical manpower for the steel industry, a task force comprising of members drawn from industry, research and education has been constituted. The members were grouped in two different committees namely, a project committee for executing the project and bringing the same to a logical conclusion as well as a core committee, whose primarily responsibility was to provide technical input and guiding the project team. At the outset, it was further envisaged that visiting industries, rationalisation of data together with analysis of raw data and preparation of a final report shall all be the responsibility of the project committee. Following a detailed consultation with the Ministry, members for the two committees were identified. For expert guidance and useful input, in addition to the above, an expert committee comprising of eight distinguished personalities, well conversant with the issue under consideration was also constituted. The constitution of the three committees is shown in Appendix I.

Following the meeting of the core and project committee held at IIT Kanpur during August 18^{th} and 19^{th} (see Fig.2.1), appropriate set of questionnaires were developed for ten different sectors, connected directly and indirectly with iron and steel production in the country. These, for example included:

- (i) Integrated steel plants
- (ii) Alloy steel plants
- (iii) Induction furnace based plants
- (iv) Ferro alloy plants
- (v) Sponge iron making units
- (vi) Merchant Pig iron plants
- (vii) Rolling and rerolling mills including coating units
- (viii) Mineral beneficiation and pelletisation plants
- (ix) Refractory industries and
- (x) R&D, design and consulting organisations

A set of questionnaires were also framed for the educational institutes to seek data on intake, number of pass outs and number of graduates/diploma holders taking up jobs with steel and allied industries. The questionnaires formulated to execute the present study are summarised in Appendix II. It is to be noted here that the questionnaires for the manufacturing sector were so formulated that information on the number and distribution of technical manpower engaged in manufacturing as well as R&D+QA *vis a vis* annual production can be gathered from each organisation. The feedback provided by various organisations formed the starting point of calculations for requirement of technical manpower for domestic steel and allied sectors. This is outlined in detail in the subsequent sections.

Figure 2.1 Members present during the first project meeting held at IIT Kanpur in August 2014 ((L): Mr. B.Roy, Mr. RN Parbat, Dr. T.Venugopalan, Mr. D.Kashiva , Mr. R.N. Bagchi, Dr. S.Banerjee, Mr. ACR Das, Dr. VK Gupta, Dr. A Ghosh, Mr. S. Ghosh and Dr. A.K.Sing:(R)).

2.2 Data collection

Questionnaires, supported with letters from the PI as well as from the Joint Secretary, Ministry of Steel were sent to two hundred and forty organisations from ten different sectors as shown in Table 2.1. Industries/organisation in each sector to whom questionnaires were sent is summarised in Appendix III. The organisations were given sufficient time to respond to the questionnaire and option to provide feedback electronically as well as through post were given. Almost simultaneously, some members of the core and project committee visited several industries under each sector so that reliable data could be gathered expeditiously. The exercise also facilitated rationalisation of data. A reasonably large numbers of responses were obtained within three months from the day questionnaires were mailed.

As seen from Table 2.2, two hundred and forty one organisations from different sectors were contacted and questionnaires were mailed to these organisations. By post, through electronic mails as well as site visits, feedback from one hundred and ninety organisations could be obtained. Of all the sectors, the participation of the primary steelmaking sector was overwhelming. Under this category, all but one organisation responded. Table 2.2 also includes the feedback statistics of the previous study. These are included within parenthesis in the last column. In comparison to the 2007 study, more industries/organisations participated in the present survey.

Table 2.1 Ten different sectors and the corresponding number of industries/organisation in each sector to whom questionnaires were sent[6].

No.	Name of the sectors	Number of industries to whom questionnaires have been mailed	Number of industries visited
01	Integrated Steel Plants	14	06
02	Alloy Steel Plants	25	05
03	Induction Furnace	46	23
04	Sponge Iron Plants	45	03
05	Re-Rolling Mills	46	110
06	Refractory Industries	08	-
07	Ferro Alloy Plants	17	02
08	Merchant Pig Iron Plants	23	-
09	Mineral Beneficiation & Pelletizing Plants	05	-
10	R & D and Design Organizations	12	-

Table 2.2 Number of industries who responded to the questionnaires for all ten sectors considered in the study.

No.	Name of Sectors	Number of industries to whom questionnaires were sent	Number of industries from whom Information received
01	Integrated Steel Plants	14	13 (10)
02	Alloy Steel Plants	25	13 (11)
03	Induction Furnace	46	24 (19)
04	Sponge Iron Plants	45	09 (24)
05	Re-Rolling Mills	46	114 (-)
06	Refractory Industries	08	05 (-)
07	Ferro Alloy Plants	17	04 (-)
08	Merchant Pig Iron Plants	23	03 (07)
09	Mineral Beneficiation & Pelletizing Plants	05	02 (-)
10	R & D Sectors	12	03 (10)
	TOTAL	241	190 (81)

[6] Steel plants having capacity above 1 MTPA has been included under the integrated sector. On the other hands steel plants having EAF technology and producing less than 1MTPA have been included under alloy steel plants. Alloy steel plants + Induction furnace steelmakers together constitute the so called secondary sector

Table 2.3 A summary of sector wise annual production and associated technical manpower as reflected from the figures provided by different organisations.

No.	Sectors(no of organization)	Production, '000 Tonne	Total technical manpower in production[7]	Technical personnel per thousand tonne of product
01	Integrated steel plants(13)	53047	64938	1.2241
02	Alloy steel plants(13)	7436	9563	1.286
03	Induction furnace steelmakers(24)	893	662	0.7413
04	Sponge iron plants(09)	992	210	0.2116
05	Re-rolling mills(114)	4602	1392	0.3024
06	Refractory industries(05)	409	324	0.7921
07	Ferro alloy pants(04)	279	160	0.5734
08	Merchant pig iron plants(03)	1288	570	0.4425
09	Mineral beneficiation & pelletizing plants(02)	8300	258 Total: 78077	0.0311

2.3 Analysis of data on productivity and technical manpower

On the basis of the responses obtained from steel and the various allied industries, sector-wise total annual production *vis a vis* technical manpower has been estimated. This is shown in Table 2.3. Since all organisations in any given sector have not participated or responded to the survey, information pertaining to sector–wise production and associated technical manpower shown in Table 2.3 is incomplete. Data presented in Table 2.3 indicates that nearly 80% of the total technical manpower is engaged with the primary steel producers. This, as one would note is somewhat skewed and follows from the fact that comparatively few secondary producers, sponge iron units etc. have responded to the survey. As a result, data presented in Table 2.3 cannot be extrapolated in a straightforward manner or used to carry out a meaningful analysis of future requirement of technical manpower in steel and the allied sectors. Despite such, the data provides useful insight and were employed to deduce important sector specific information (used as relevant scalable parameter later) such as, "technical personnel per thousand tonnes of product". Since organisations have provided information on skill set-wise and discipline-wise information on technical manpower as well, similar discipline specific parameters such as "diploma or graduate engineers per thousand tonnes", "metallurgical engineers per thousand tonne of product", "mechanical engineers per thousand tonne of product" etc. can also be conveniently estimated and employed in subsequent

[7] Throughout, technical personnel engaged in maintenance and other allied services of steel plants are included in the head.

calculations/extrapolations. These i.e., the sector specific as well as discipline specific scalable parameters are illustrated in Appendix IV.

Table 2.4 Actual total production of different sectors in 2014 and the estimated associated technical manpower.

Sectors	Data from survey		Actual production in 2014, '000 Tonne	Estimated technical manpower in production
	Production in 2014, '000 Tonne	Total technical manpower in production		
Integrated steel plants	53047	64938	55000	67328
Alloy steel plants	7436	9563	12000	15432
Induction furnace steelmakers	893	662	14000	10378
Sponge iron plants	992	210	22900	4848
Re-rolling mills	4602	1392	41200	12462
Refractory industries	409	324	1150	911
Ferro alloy plants	279	160	2000	1147
Merchant pig iron plants	1288	570	7950	3518
Mineral beneficiation and pelletisation units	8300	258	25000	777
		Total: 78077		Total: 116801

Since sector wise productivity and manpower shown in Table 2.3 are not truly representative, consequently, to proceed further, organisations like INSDAG, SIMA, IRMA, NISST as well as Ministry of Steel were contacted to obtain sector wise actual productivity in 2014. Information thus obtained are summarised in Table 2.4. There, for the sake of comparison, sector-wise annual productivity and the corresponding number of associated technical manpower, which were presented already in Table 2.3, have also included. Given the actual sector specific productivity in 2014, on the basis of numbers shown in the first two columns, estimates of technical personnel associated with each sector can be easily made trough linear extrapolation and this is shown in the last column of Table 2.4. As seen, currently, nearly 116801 technical personnel are expected to be there in the pay roll of various organisations taken to constitute the nine different sectors in the study. Results presented in Table 2.4 are illustrated via a pi-diagram in Fig. 2.2. This indicates that almost 80% of the technical manpower is with the steel plants (integrated and secondary producers combined) while remaining 20% are with the allied industries. Furthermore, integrated steel plants employ nearly 58% of the entire technical task force.

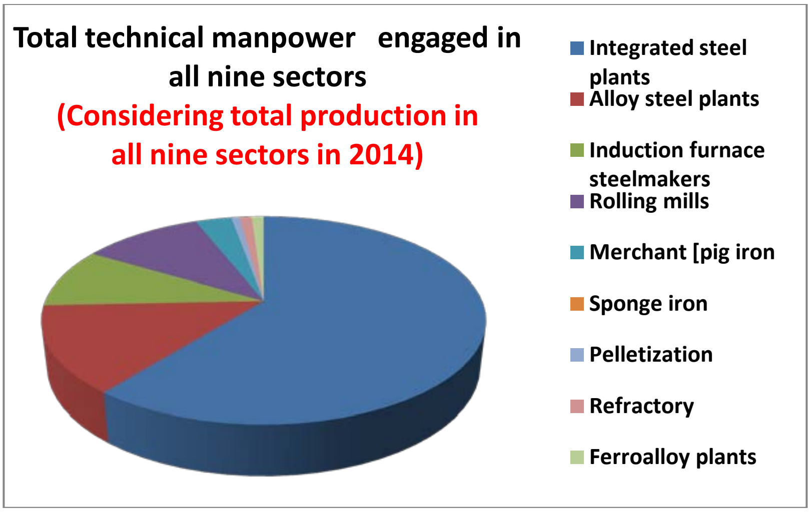


Figure 2.2 Proportionate share of technical manpower in all sectors estimated on the basis of numbers deduced from actual sector-wise total production.

The reported total technical manpower associated with production as shown in Table 2.4 includes graduate engineers, diploma engineers and ITI certificate holders in the company pay roll and precise numbers of these were provided by each organisation *vis a vis* annual production, who participated in the survey. Organisations, who responded to the questionnaires, have also provided separately, the number of technical personnel along with their qualifications, engaged in the R&D and QA segment. Based on such, number of technical personnel in production and R&D (including QA) per thousand tonne of product was estimated for each sector. Given the current total productivity and the associated manpower in each sector (Table 2.4), number of graduate engineers, diploma engineers and ITI certificate holders could be easily mapped for each sector through linear extrapolation embodying the corresponding "number per thousand tonne of the product" figure shown in Appendix IV. The number of graduate engineers, diploma engineers and ITI certificate holders associated with production and R&D thus estimated are summarised in Table 2.5 for each sector along with sector specific, total, estimated annual production. There, it is readily apparent that of the estimated total 1,16,801 technical personnel associated production in the nine sectors in 2014 , nearly 42% are ITI trained, 29% are Diploma engineers and 29% are graduate engineers. Several interesting observations can be made from Table 2.5 and these are summarised below:

●the integrated steel plants i.e., the primary sector employs the largest number of engineers and ITI certificate holders,
●practically 80% of the total technical personnel is associated with the steel manufacturers i.e., remaining 20% is associated with the allied sectors,
● the number of technical personnel associated with R&D and QA, in any sector, is very small. Barely 5 to 6 % of the entire task force is engaged in the R&D and QA activities. This will be addressed in later section in detail and finally,
●the proportion of graduate and diploma engineers engaged in steel and allied sectors is roughly 1:1.

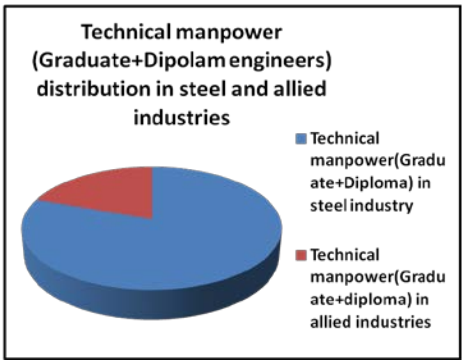
Table 2.5 Estimated sector–wise numbers of graduate engineers, diploma engineers and ITI trained personnel engaged in production and R&D (including QA) in all nine sectors as in 2014.

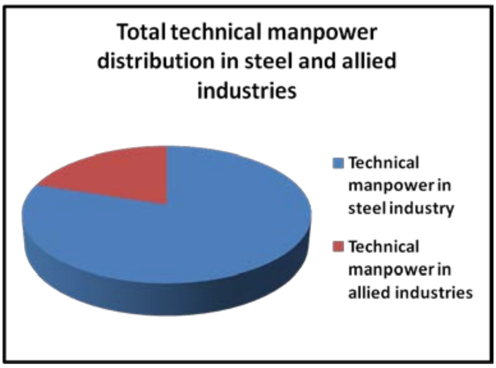
Sectors	Total production	Graduate Engineers			Diploma Engineers			ITI Trained
		Prod.	R & D + QA	Total	Prod.	R & D + QA	Total	
Integrated Steel Plant	55000	19854	1072	20927	18502	1650	20152	28972
Alloy Steel Plant	12000	4299	285	4584	4218	403	4622	6915
Induction Furnace units	14000	3103	16	3119	3040	375	3415	4232
Sponge Iron Plant	22900	577	23	600	1822	00	1822	2446
Re-rolling Mills	41200	3437	143	3580	2963	241	3202	6060
Refractory Industries	1150	224	194	418	444	00	444	241
Ferro Alloy Plant	2000	107	00	106	222	00	222	817
Merchant Pig Iron	7950	1733	74	1795	907	25	931	876
Mineral beneficiation+ Pelletissation	25000	290	38	330	318	12	331	165
Total		33619	1845	35459	32436	2706	35141	50724

2.4 Manpower requirement prediction: principle and procedure

In estimating requirement of technical manpower to manage and sustain 300 MMTPA steel production by 2025, a report by MECON (acquired through INSDAG) has been considered. This suggests that by 2025, nearly 240 million tonnes of steel is likely to be produced in the integrated sector and about 60 million tonnes in the secondary sector (alloy steel plants + EIF steelmakers combined). Therefore, estimates of required manpower for primary and secondary sectors are possible through linear extrapolation, given the numbers in Table 2.5. In contrast, evolution of the allied sectors during the next ten years, parallel to the growing steel production, is less certain. Furthermore, there is currently no basis to firmly assert and thereby assign meaningful future annual productivity figures against the various allied sectors. Since production levels in the allied sectors are uncertain, estimates of manpower for allied industries cannot be derived through extrapolation.

The present analysis, as already pointed out, has indicated that technical manpower in steel and allied industries is currently in proportion to 80:20. The 80:20 ratio of technical manpower at each skill set has been further investigated and established through careful analysis. This is demonstrated in Fig. 2.3. There, it is readily apparent that between the steel and allied industries, the ratio of total technical manpower as well as engineers is nearly in the ratio of 80:20 (i.e., 42814:10604 is equivalent to 81:19). Naturally therefore, these two segments will show the same 80:20 ratio of ITI trained personnel as well!





(a) (b)

Figure 2.3 Relative proportion of technical manpower in steel and allied industries. (a) total technical manpower distribution and (b) distribution of graduate + diploma engineers.

The preceding figures appear to indicate that if technical manpower requirement for steel plants is mapped through linear extrapolation as stated earlier, It is possible to reasonably approximate the corresponding requirement for the allied sector as well considering the 80:20 distribution between the two segments. Summing up the two, the total manpower requirement for steel and allied industries can be conveniently determined. The number thus established can be further split down in proportion to 42:29:29 (see Sec.2.3) to find out the distribution and corresponding numbers of ITI certificate holders, graduate as well as diploma engineers. Given such, we need to consider in detail the requirement of technical manpower for the steel producing sector only (primary as well as secondary producers). This is outlined in the following section.

Table 2.6 Distribution of technical manpower at different skill set in the three steel producing sectors.

No.	Name of steel producing sector	Total prod., '000 Tonne	Technical manpower			
			Total	Graduate	Diploma	ITI
01	Integrated	55000	67328	19853	18502	28973
02	Alloy Steel	12000	15432	4299	4218	6915
03	EIF	14000	10378	3104	3041	4233
	Total		93138	27256	25761	40121

2.4.1 Assumptions in scale-up

In Table 2.4, total technical manpower engaged in production in the primary and secondary steel sectors have been shown. Corresponding, skill set-wise distribution, for each of the three types of steel plants viz., integrated, alloy steel and EIF based steel plants *vis a vis their* current production is shown in Table 2.6. There, as one would note, alloy steel plants and EIF based units, appearing at serial numbers 02 and 03 in the first column, represent in combination the so called secondary producers. We shall club them together at an appropriate stage later. Table 2.6 indicates that practically 72% of the total technical manpower is associated with the primary producers and the remaining 28% with secondary (alloy steel plants +EIF units). This distribution is illustrated in Fig. 2.4. It is to be mentioned here that practically similar conclusion follows if, instead of total technical manpower, for example, graduate or diploma engineers or ITI certificate holders were considered for elucidation in Fig.2.5.

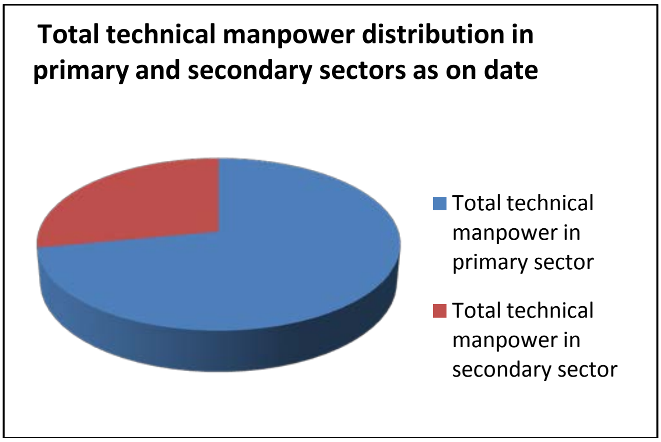


Figure 2.4 Distribution of total technical manpower, engaged in production, in the primary and secondary steelmaking sectors.

Since in 2025, production in the primary and secondary sectors are likely to be about 240 and 60 MMTPA respectively, therefore, data presented in Table 2.6 can be extrapolated in a straightforward fashion to determine the corresponding number of technical personnel (graduate engineers + diploma engineers + ITI certificate holders) likely to be engaged in production. But is the extrapolation or scale up process so simple? Complexities arise due to many issues, for example,

- Will a steel plant in 2025 be operated with same machinery or have similar level of automation as of the present time?
- How manpower intensive shall a steel plant be in 2025?
- Will the secondary sector evolve as efficiently as the primary sector?
- What is the likely effect of presently employed technical personnel and superannuation on the estimated numbers?
- How shall the allied industries evolve over the next 10 years?

There are indeed numerous uncertainties involved in the scale up process. Modernisation of existing steel plants and level of automation in the new plants are perhaps likely to exert most profound influence on the number of technical personnel required to produce any given amount of steel in the future. To arrive at plausible numbers, two extreme possibilities are considered. These allow us to extrapolate to the future and help arrive at a maximum as well as a minimum number, so far as the requirement of technical personnel in future steel industries is concerned. These are, for example:

(i) the upper bound model: this assumes that steel plants in 2025 shall be as man power intensive as these are today implying very little or no modernisation and
(ii) the lower bound model: this assumes that future steel plants in 2025 shall be modern and efficient, comparable to those of advanced steelmaking nations, such as, Japan.

To obtain some data on productivity and technical manpower, and to carry out extrapolation via approach (ii), Japanese Universities and industries were contacted. A professor from Tohuku University, who was in India during November 2014, also visited IIT Kanpur for discussion. Some numbers on manpower and production were also obtained from the respective company website. In the analysis presented in the following, it has been assumed that while the number of engineers and researchers shall vary according to the two above mentioned bounds, the number of ITI trained personnel shall largely remain independent of these. In other words, present day steel mills and future modern steel mills shall roughly employ the same number of ITI certificate holders referenced to per million tonne of steel produced

Table 2.7 Extrapolated maximum numbers (upper bound) of technical manpower at different skill set required in the primary and secondary steel producing sectors.

No.	Steel producing sector	Total prod., '000 Tonne	Technical manpower			
			Total	Graduate Engineers	Diploma Engineers	ITI certificate holders
01	Integrated or primary producers	240,000	2,93,795	86636	80736	1,26,423
02	Secondary producers	60,000	59554	17,081	16749	25,724
	Total		3,53,349	1,03,717	97485	1,52,147

2.4.2 The upper bound

Since skill set wise technical manpower per thousand tonne of steel (see Appendix IV) for integrated, alloy and induction furnace based steel plants is already established , consequently given the target productivity of the two sectors (240 and 60 MMMTPA respectively), straightforward extrapolation can be done to deduce the corresponding numbers. This is shown in Table 2.7. Thus, to produce 300 Million tonne of steel in the next 10 years, nearly three and a half lack (exactly 3,53,349) technical personnel shall be required[8]. As seen, numbers of graduate and diploma engineers required are roughly in 1:1 proportion reflecting the very nature of current employment statistics summarised earlier. It is important to note that the figure under the head "total" in Table 2.7 represents only 80% of the total manpower requirement since remaining 20% is lies with the allied sectors. Furthermore, effect of presently employed technical personnel and their superannuation is required to be accommodated in the calculation scheme in order to arrive at more pragmatic and accurate figures. These will be addressed subsequently at appropriate sections.

Table 2.8 A comparison of productivity vs. manpower in steel plants (integrated and alloy steels plants) in India and Japan in 2014

Production, MTPA	Total Engineers	Total engineers per thousand Tonnes	Total Mechanical Engineers	Total Metallurgical Engineers
Japanese steel plants				
31 (Integrated steel plants)	2247	0.072[9]	820	737
3.7 (Alloy Steel plants	985	0.27	350	250
Indian steel plants				
53 (Integrated steel plants)	20188	0.38	7500	3488
7 (Alloy Steel plants	2841	0.39	1400	431

2.4.3 The lower bound

The lower bound on technical manpower, as pointed out already, was estimated considering productivity and technical manpower in Japanese steel plants. Both integrated and alloy steel plants were considered and relevant data were collected through personal contacts /communications/discussions. In Table 2.8, a comparison of present day status of technical manpower, associated with steel mills in India and Japan is presented. As seen, Japanese integrated as well as alloy steel plants, employ far too less technical manpower, in comparison to ours, to manage their steel production. As seen, engineers needed to produce a thousand tonnes of steel differ by more than a factor of 4, between the two countries. Extensive automation, efficient process control and modern technology naturally make Japanese steel mills less

[8] This corresponds to roughly 118 technical personnel per million ton per year. With allied sectors included, a more realistic estimate stands at 147 per million tonne per year (effect of existing employees and thier superannuation not included).

[9] Shougang Jingtang united iron and steel works in China, a very modern ~7 MTPA steel plant employs about 800 engineers in its task force. This corresponds to 0.11 engineers per thousand tonne of steel produced. This was found out during a visit by the co-PI to the said industry during ICS2015 at Beijing.

technical manpower intensive. Interestingly, while Japanese steel plants employ mechanical and metallurgical engineers roughly in 1:1 proportion, the ratio is significantly larger for Indian steel plants. As will be shown latter and discussed, Indian steel plants are predominantly managed by mechanical and electrical engineers rather than metallurgical engineers, since the former types are relatively more needed to sustain daily production.

Table 2.9 Extrapolated minimum numbers (lower bound) of technical manpower at different skill set required in the primary and secondary steel producing sectors in the next ten years for a target production of 300 MT of steel.

No.	Ssectors	Total production, '000 Tonne	Technical manpower (deduced on the basis of appropriate factor from Table 2.8)			
			Total	Graduate engineer	Diploma engineer	ITI trained
01	Integrated or primary producers	240,000	158135	16415	15297	126423
02	Secondary producers	60,000	48187	11825	11595	25724
	Total		214348	28240	26892	152147

Thus, if all Indian steel mills in the primary and secondary sectors in 2025 are taken to be as modern and efficient as the Japanese steel plants of today, we may assume similar "number of engineers per thousand tonnes of steel" (as shown in Table 2.8) and deduce the corresponding number of engineers (graduate + diploma engineers, a part of the total technical manpower) required to manage 300 MT of steel production annually. The resultant numbers, as one might anticipate here, are going to substantially smaller than those presented in Table 2.7. The lower bound numbers thus obtained are shown in Table 2.9. It is interesting to note that there is, as expected, substantial difference between the upper and the lower bounds (see Tables 2.7 and 2.9 respectively; number of total engineers there almost by a factor of 3 or so). It is anticipated that in the years to come, as more steel plants are set up and the existing ones modernise, the final figure shall settle somewhere in the range between those shown in Tables 2.7 and 2.9. A firm and more definitive number perhaps cannot be derived and should not be advocated due to numerous uncertainties and complexities associated with the very nature of the task. It is reiterated that the number of ITI trained personnel, which was deduced through straightforward extrapolation (viz., 152147 in Table 2.7), remains unchanged and is irrespective of the bounds.

2.5 Skill set- wise technical man power requirements

As pointed out already, regardless of the bounds, nearly 152147 ITI trained personnel shall be required to run steel mills (primary and secondary sectors combined) in 2025 to produce 300 MTPA steel in the country. In contrast, depending on how developments take place in various fronts and modernisation of steel plants progresses, graduate and diploma engineers in the range 55136 and 2,01,202 shall be required over a period of next ten years shall. However, related issues such as (i) employment is allied sectors and (ii) existing employees as well as their superannuation are required to be considered to arrive at the final figures. It is to these we now turn our attention to.

2.5.1 Requirement of ITI certificate holders

In section 2.4 (see Fig.2.3), it was analytically demonstrated that currently about 80% of total technical manpower is associated with the steel plants (primary and secondary combined) while remaining 20% with the relevant allied sectors such as sponge iron plants, ferroalloy plants, rolling mills etc. This, as a consequence, implies that number of ITI trained personnel required for the steel and allied sectors combined can be readily obtained by multiplying the corresponding numbers for steel industries alone (see Table 2.7) by a factor of 1.25 (i.e., =1.25*152147). Therefore considering allied sectors together with primary and secondary steel producing sectors, nearly 190184 numbers of ITI trained personnel shall be required. However, according to Table 2.5, there are already 50,724 number of ITI personnel employed already in steel plants and allied industries. Feedback obtained from various quarters suggested that almost 25% of the technical staff members employed in the steel and allied industries are in the age group of 50 to 60, who will not be available in the work place in 2025. This implies an annual attrition of about 2.5% due to superannuation. It is instructive to note that the 2007 study considered an overall annual attrition rate of 3% due to superannuation. Given such, it is legitimate to consider that 75% of the existing ITI certificate holders (0.75*50724=38043) shall continue to be in the company payroll during the next ten years. Hence the effective number of ITI trained personnel required during the next ten years to produce 300 MT of steel can be obtained by subtracting 38043 from 190184. This is equivalent to 152141. Hence it is concluded that per annum, per million tonne, nearly 692 ITI trained personnel holders shall be required by the steel and the relevant allied industries combined. As discussed in Chapter 3, the requirement and the above mentioned number is far too smaller than the annual number available from ITI's nationwide.

There is an apprehension that the required number of ITI trained personnel indicated above is far too small than the actual. Many of the organizations outsource jobs (viz., welding, plumbing, electrical etc.) and hence it is likely that ITI trained personnel actually serving steel industries is not truly reflected in the numbers indicated by the companies. However, in the absence of concrete data on the point, projected numbers cannot be changed. Looking at the issue from a different angle, with future automation in modern steel plants, requirement of ITI trained personnel shall be smaller than projected. This also needs to be kept in my mind when dealing with the number of ITI trained personnel required for steel industry.

2.5.2 Requirement of Graduate and Diploma Engineers

By appropriate scale up criteria, required numbers of graduate and diploma engineers engaged in production were already worked out in the preceding section (see Tables 2.7 and 2.9 respectively). If such estimates are corrected by taking into account the current employment and as well as likely superannuation, more realistic and accurate estimates of requirements can be made. Revised estimates of requirements thus obtained, for the upper and the lower bounds, are shown in Tables 2.10(a) and 2.10(b) respectively. Since, discipline wise graduate and diploma engineers per thousand tonne of product are already estimated from the survey results (see Appendix IV), consequently, required number of mechanical, electrical, metallurgical, chemical engineers etc. can be easily estimated for upper as well as lower bounds. This is illustrated in the subsequent sections.

Table 2.10(a) Numbers of graduate and diploma engineers required according to the upper bound in the next ten years for a target production of 300 MT of steel.

Sector	Requirements	Graduate Engineers	Diploma Engineers
Primary and secondary steel producers combined	No adjustment for existing staff	103717	97486
	With adjustment for existing staff	1,03,717-0.75x27256= 83275	97,486-0.75x25760= 78166

Table 2.10(b) Numbers of graduate and diploma engineers required according to the lower bound in the next ten years for a target production of 300 MT of steel.

Sector	Requirements	Graduate Engineers	Diploma Engineers
Primary and secondary steel producers combined	No adjustment for existing staff	28,280	26,892
	With adjustment for existing staff	28,280-0.75x27256= 7838	26,892-0.75x25760=7572

2.5.3 Discipline-wise technical man power requirements for production

Based on the estimates shown in Tables 2.10(a) and 2.10(b) respectively and embodying information given in Appendix IV, discipline- wise requirements of graduate and diploma engineers have been calculated for primary and secondary sectors separately. Estimates were made for both upper as well as lower bounds. Details of these are presented in the following.

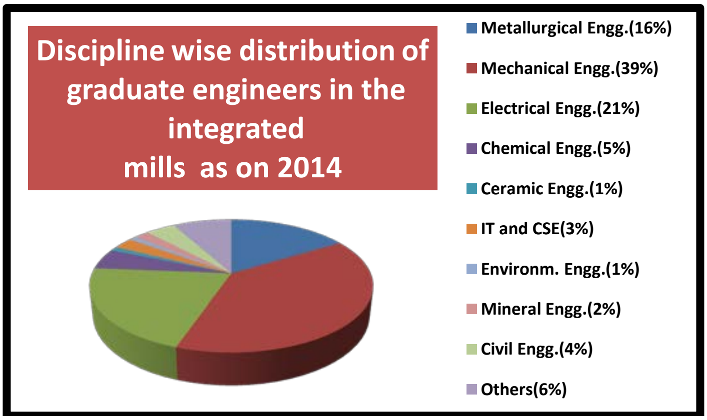


Figure 2.5 Discipline –wise distribution of graduate engineers in integrated steel plants in 2014.

Table 2.11 Discipline wise requirement of graduate engineers in the primary steel producing sector according to the upper bound

Engineering discipline	% share of total (2)	Gross number in production (3)	Number in R&D and QA (4% of 3) (4)	Manpower in Prod. +QA (3+4) (5)	Requirement for allied Sector (20% of 5) (6)	Net required (5+6) (7)
Metallurgy	16	11479	459	11938	2388	14326
Mechanical.	39	27981	1119	29100	5820	34920
Electrical	22	15784	631	16415	3283	19698
Chemical	05	3587	144	3731	746	4477
Ceramic	01	718	29	747	149	896
IT & CSE	03	2152	86	2238	448	2686
Environmental	01	718	29	747	149	896
Mineral	03	2152	86	2238	448	2686
Civil	04	2870	115	2985	597	3582
Others	06	4305	172	4477	895	5372
Total	100	71746	2870	74616	14923	89539

2.5.3.1 The upper bound

By translating the information contained in the Appendix IV into a pi diagram, Fig.2.5 has been constructed to show the discipline–wise distribution of graduate engineers in the existing technical manpower in steel industries. This indicates that integrated mills in India are overwhelmingly managed by mechanical and electrical engineers. Since the total number of graduate engineers required for primary sector is 71746 (= 86636 - 0.75 X19854 in which, 19854 is the currently employed graduate engineers and 0.75 is their availability considering superannuation), consequently, the latter number can be proportionately distributed according to Fig.2.5 to deduce discipline-wise requirement of graduate engineers. This is shown in Table 2.11.

Since the percentage (%) numbers shown in Fig.2.5, corresponds to the production only, consequently discipline wise numbers were first calculated for production only. This is shown in column 3 of Table 2.11. Since approximately 4% of technical staff is shown to be involved in Q&A (and too some extent, in routine, R&D activities), consequently estimated values in column 3 were further increased by 4% to represent the number of total graduate engineers in the primary steel producing sector (column 5) . Finally, to accommodate the allied sectors and to estimate the net requirement, numerical values in column 5 were enhanced by 20%. The resultant final numbers are shown in column 7 of Table 2.11. Exactly similar procedure was adopted to determine the net numbers of graduate engineers for the secondary sector which is illustrated through Fig.2.6 and Table 2.12 respectively.

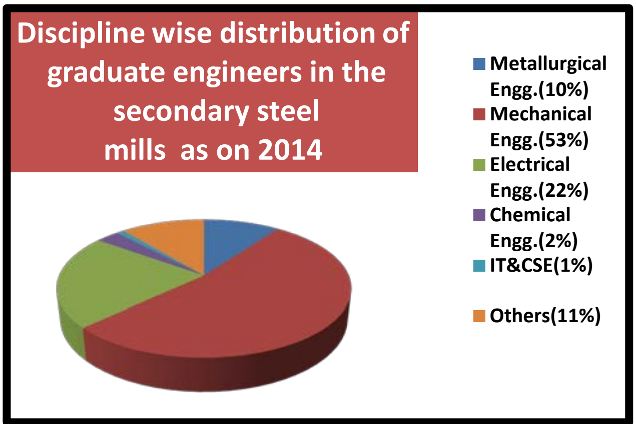


Figure 2.6 Discipline –wise distribution of graduate engineers in secondary steel producing sector in 2014.

Table 2.12 Discipline- wise projected requirement of graduate engineers in the secondary steel producing sector, according to the upper bound.

Engineering discipline	% share of total (2)	Gross number in production (3)	Number in R&D and QA (4% of 3) (4)	Manpower in Prod. +QA (3+4) (5)	Requirement for allied Sector (20% of 5) (6)	Net required (5+6) (7)
Metallurgy	10	1153	46	1199	240	1439
Mechanical	53	6111	244	6355	1271	7626
Electrical	22	2537	101	2638	527	3165
Chemical	3	346	14	360	72	432
IT & CSE	1	115	5	120	24	144
Others	11	1268	51	1319	264	1583
Total	100	11530[10]	461	11991	2398	14389

[10] 11530 is equal to 17081 (see Table 2.7) minus 0.75x 7402 in which 7402 is the existing number of graduate engineers in the secondary sectors.

Once again, these clearly indicate that secondary sector too is primarily managed by mechanical & electrical engineers. Practically 75% of the total graduate engineers are from mechanical and electrical engineering disciplines! Equivalent requirements of diploma engineers for the primary and secondary sectors are illustrated through Figs. 2.7 and 2.8 as well as Tables 2.13 and 2.14.

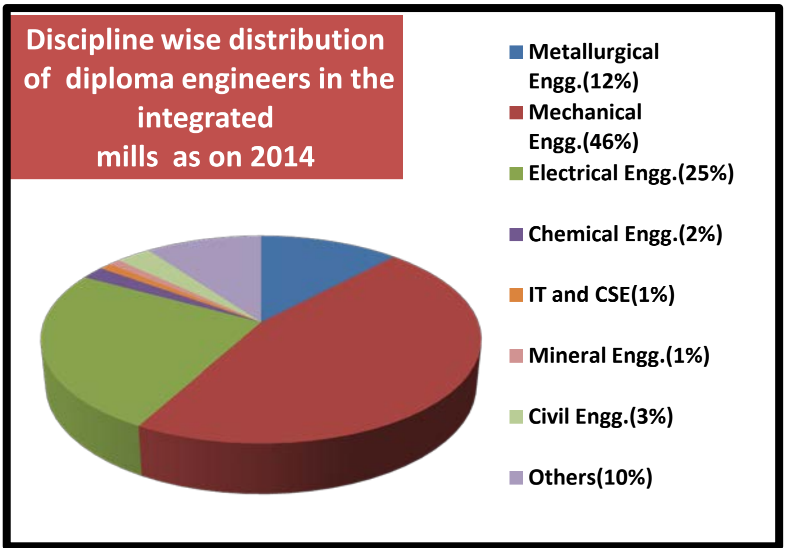


Figure 2.7 Discipline –wise distribution of diploma engineers in the primary steel producing sector as in 2014.

Table 2.13 Discipline- wise projected requirement of diploma engineers in the primary steel producing sector according to the upper bound

Discipline	% share of total (2)	Gross number in production 3)	Number in R&D and QA (4% of 3) (4)	Manpower in Prod. +QA (3+4) (5)	Requirement for allied Sector (20% of 5) (6)	Net requirement (5+6) (7)
Metallurgy	12	8023	321	8344	1669	10013
Mechanical	46	30756	1230	31986	6397	38383
Electrical	25	16715	669	17384	3477	20861
Chemical	2	1337	53	1390	278	1668
IT & CSE	1	669	27	696	139	835
Mineral	1	669	27	696	139	835
Civil	3	2006	80	2086	417	2503
Others	10	6686	267	6953	1391	8344
Total	100	66861[11]	2674	69535	13907	83442

[11] 66861 is equal to 80737 (see Table 2.7) minus 0.75x 18502 in which 18502 is the existing number of diploma engineers in the primary sectors.

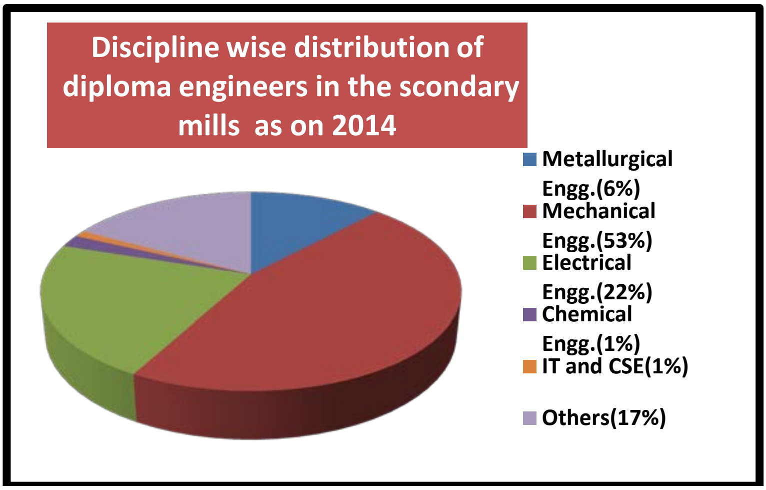


Figure 2.8 Discipline –wise projected distribution of diploma engineers in the secondary steel producing sector as in 2014.

Table 2.14 Discipline- wise projected requirement of diploma engineers in the secondary steel producing sector according to the upper bound

Engineetring discipline	% share of total (2)	Gross number in production (3)	Number in R&D and QA (4% of 3) (4)	Manpower in Prod. +QA (3+4) (5)	Requirement for allied Sector (20% of 5) (6)	Net required (5+6) (7)
Metallurgy	6	678	27	705	141	846
Mechanical	53	5992	240	6232	1247	7479
Electrical	22	2488	100	2588	518	3106
Chemical	1	113	4	117	23	140
IT & CSE	1	113	4	117	23	140
Others	17	1922	77	1999	400	2399
Total	100	11306[12]	452	11758	2352	14110

The two preceding tables and figures also reflect that mechanical and electrical disciplines constitute the major portion of diploma engineers both in the primary and secondary steel producing sectors. Furthermore, projected requirements of graduate and diploma engineers, as per the upper bound, are roughly in 1:1 proportion (103928 vs. 97552) reflecting essentially the composition of the current engineering task force and the consequence of straightforward scale up. An interesting feature that comes out of the analysis in this section is mechanical, electrical and metallurgical engineers constitute roughly 80% of the technical task force in the steel plants (both primary and secondary combined).

[12] 11306 is equal to 16749 (see Table 2.7) minus 0.75x 7258 in which 7258 is the existing number of diploma engineers in the secondary sectors.

2.5.3.2 The lower bound

In Table 2.10(b) estimates of graduate and diploma engineers according to the lower bound have been presented considering the present task force and the effect of superannuation. The same is reproduced below, in Table 2.15 for continued discussion and ready reference. A model is now needed to distribute the numbers of graduate and diploma engineers among various relevant disciplines.

Table 2.15 Numbers of graduate and diploma engineers required according to the lower bound in the next ten years to produce 300 MT of steel

Sector	Requirements	
	Graduate engineers	Diploma engineers
Primary +secondary producers combined (the effect of present employees and their superannuation included)	7838	7572

Steel plants in Japan are managed with large number of mechanical and metallurgical engineers (~ 50%). Typically, technical task force consists of Metallurgical, Mechanical and engineers from other disciplines, nearly in proportion to 1:1:2. In contrast, feedback from Indian steel plants indicates that the same ratio in our steel plants is approximately 1:4:5. Since it is already shown (see Table 2.14) that almost 80% of the technical task force in our steel plants are typically mechanical, metallurgical and electrical engineers (engineers from other disciplines collectively constitute the remaining 20%), we can, adopting the composition of technical manpower in steel plants in Japan, distribute the numbers shown in Table 2.15 among metallurgical, mechanical, electrical and engineers from other disciplines in proportion to 4:4:4:3. The balance (= 20%) technical task force (engineers from all other engineering disciplines are included in this), can be proportionately distributed among various streams or disciplines following the current trends as: chemical (3%), ceramic (2%), mineral (2%), IT&CSE (2%), civil(3%), environmental (1%) and the balance (7% or so) as others.

On the basis of above considerations, the total numbers of engineers shown in Table 2.15 (i.e., the lower bound estimates) have been distributed among three primary disciplines and others and the result thus obtained is summarized in Table 2.16. Embedded in the model calculations is the presumption that it is possible to manage steel mills far more efficiently, as Japanese could do, provided a large number of metallurgical engineers constitute the technical task force.

Since the figures shown in Table 2.16 include technical personnel associated with both production and R&D, and that efficient steel mills worldwide (including those in Japan) operate with nearly 20% highly qualified, R&D engineers, we need to subtract 20% from the above and multiply the resultant numbers by 1.25 to embody manpower from the allied sectors in order to get discipline wise, final figures for production, corresponding to the lower bound. Such manipulation, as one would normally anticipate is unlikely to change numbers as indicated in Table 2.17.

Table 2.16 Discipline wise projected numbers of graduate and diploma engineers required for steel industries according to the lower bound in the next ten years to produce 300 MT of steel.

Graduate engineers- Total required number : 7838		
Engineering discipline	Proportionate share as per the model of efficient steel plants	Discipline-wise total number required
Metallurgical	26.67%	2090
Mechanical	26.67%	2090
Electrical	26.67%	2090
Others	20%	1568
Diploma engineers: Total required number is 7572		
Metallurgical	26.67%	2019
Mechanical	26.67%	2019
Electrical	26.67%	2019
Others	20%	1515

Table 2.17 Discipline wise projected numbers of graduate and diploma engineers required for all nine sectors (steel plants +allied industries) according to the lower bound in the next ten years to sustain 300 MTPA of steel production.

Engineering discipline	Graduate Engineers (10 year requirements)		Discipline-wise required numbers per year
	For steel industries alone	All nine sectors combined requirement	
Metallurgical	2090	2508	251
Mechanical	2090	2508	251
Electrical	2090	2508	251
Others	1568	1882	188
Engineering discipline	Diploma Engineers (10 year requirements)		Discipline-wise required numbers per year
Metallurgical	2019	2423	242
Mechanical	2019	2423	242
Electrical	2019	2423	242
Others	1515	1818	181

2.5.3.3 The final figures

Extracts from relevant tables presented in the preceding sections can now be consolidated and summarized more comprehensively to indicate discipline-wise requirements of graduate and diploma engineers as per the upper and the lower bounds. These are shown respectively in Tables 2.18 and 2.19. As already pointed out, the actual required numbers for each discipline are likely to fall in the range shown in the two tables. More definitive prediction is not possible due to very nature of the problem and the various uncertainties associated with extrapolation. It is important to note that on top of the graduate and diploma engineers shown in the two aforementioned tables, nearly fifteen thousand two hundred fourteen (15214) ITI trained personnel shall also be needed annually to manage steel and allied industries of the future.

Table 2.18 A summary of projected discipline wise requirement of engineers in the steel and allied sectors according to the upper bound.

Engineering discipline	Graduate Engineers	Diploma Engineers	Yearly requirements	Yearly requirements
	10 year requirements		Graduate Engineers	Diploma Engineers
Metallurgy	15765	10859	1577	1086
Mechanical	42546	45862	4255	4586
Electrical	22863	23967	2286	2397
Chemical	4909	1808	491	181
Ceramic	896	insignificant	90	insignificant
IT & CSE	2830	975	283	97
Environtal	896	insignificant	90	insignificant
Mineral	2686	835	268	84
Civil	3582	2503	358	250
Others	6955	10743	696	1074
Total	103928	97552	10394	9755

Results presented in Tables 2.18 and 2.19 indicate that relatively large number of mechanical, electrical and metallurgical engineers shall be required to manage steel plants and allied industries of the future. It is important to mention that annual projected requirement for each discipline is substantially smaller than the annual GATE examinees implying essentially that availability of engineers for steel and allied industries is generally not a matter of concern. This is however not as simple. In Chapter 3, a detailed analysis on the availability of technical manpower has been presented to address possible gap between requirement and availability. It is rather well known that Indian steel plants though are productive, certainly not largely innovative. This has been analysed at length in the 2011 and 2012 reports[13]. In the following section, R&D in steel industry and the associated man power related issues are addressed in detail.

Table 2. 19 A summary of projected discipline wise requirement of engineers in the steel and allied sectors according to the lower bound

[13] 1. *A Roadmap for Research and Development and Technology for Indian Iron and Steel Industry:* Ministry of Steel, Govt.of India, 2011
2. *Success and Gaps in our Metallurgical RD Efforts*, Indian National Academy of Engineering, New Delhi, 2012.

Engineering discipline	Graduate Engineers	Diploma Engineers	Yearly requirements	Yearly requirements
	10 year requirements		Graduate engineers	Diploma engineers
Metallurgy	2508	2423	251	242
Mechanical	2508	2423	251	242
Electrical	2508	2423	251	242
Chemical	283	273	28	27
Ceramic	188	182	18	18
IT & CSE	188	182	19	18
Mineral	188	182	19	19
Civil	283	273	28	27
Others	752	726	75	73
Total	9406	9087	940	908

Requirement per year, per million tonne for upper as well as lower bounds is shown in Tables 2.20 and 2.21 respectively

Table 2.20 A summary of projected discipline wise requirement of engineers in the steel and allied sectors according to the upper bound

Engineering discipline	Graduate Engineers	Diploma Engineers	Yearly requirements per million Tonne	
	10 year requirements		Graduate Engineers	Diploma Engineers
Metallurgy	15765	10859	72	50
Mechanical	42546	45862	193	208
Electrical	22863	23967	104	109
Chemical	4909	1808	22	08
Ceramic	896	insignificant	04	insignificant
IT & CSE	2830	975	13	04
Environmental	896	insignificant	04	insignificant
Mineral	2686	835	12	04
Civil	3582	2503	16	11
Others	6955	10743	32	49
Total	103928	97552	472	443

Table 2. 21 A summary of projected discipline wise requirement of engineers in the steel and allied sectors according to the lower bound

Engineering discipline	Graduate Engineers	Diploma Engineers	Yearly requirements per million Tonne	
	10 year requirements		Graduate Engineers	Diploma Engineers
Metallurgy	2508	2423	11	11
Mechanical	2508	2423	11	11
Electrical	2508	2423	11	11
Chemical	283	273	02	~01
Ceramic	188	182	~01	~01
IT & CSE	188	182	~01	~01
Mineral	188	182	~01	~01
Civil	283	273	~02	~01
Others	752	726	03	03
Total	9406	9087	43	41

2.6 Researchers for steel plants

Word class steel mills not only produce quality steel at cheaper price (owing to state of the art technology, material and energy recycling etc.) these also provide effective solutions for managing less efficient steel mills worldwide. Nippon steel, JFE, Bao steel etc. are classic examples and represent the premier class of steel plants[14] on which not only Indian promoters rely heavily for technology but others as well. These industries could provide leadership and help drive steel industries forward because of a strong R&D. Tables 2.22 (a) and (b) show the nature of technical manpower division in a steel plant in Japan. There, as seen, 20% of the total technical personnel are the researchers. Furthermore, as gathered through personal communication, half of such research engineers in steel plants are metallurgists, who are highly qualified having generally a Ph.D. or a master degree in metallurgical engineering!!

In contrast, steel plants in India barely have 5~ 6% of their technical staff working in R&D as well as quality assurance (QA) jobs. These engineers often do not have the requisite background to initiate and execute innovative R&D exercises. This as a consequence has resulted into little or no innovation. Truly therefore, It is legitimate to consider the 6% technical personnel against QA rather than R&D. Given this, we can conclude that there is a serious deficiency of highly qualified R&D personnel in domestic steel industries. Evidently, the present situation has to change for sustaining future, world class steel industries and this necessitates that R&D is significantly strengthened in both primary and secondary steel producing sectors. To accomplish the objective, a large number of Ph.D. and master degree holders in engineering

[14] There are other solution providers as well such as Primetals (a wing of Siemens), Danieli etc. which work on future technology and help erect and modernise steel plants.

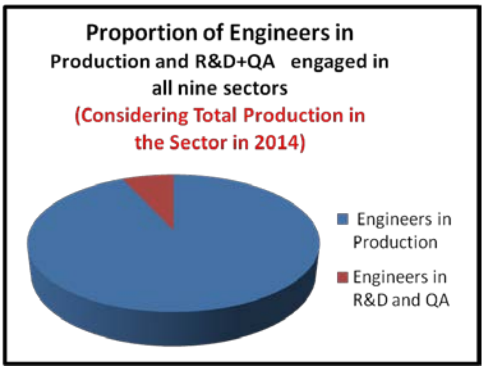
disciplines (specially in iron and steel metallurgy) shall be needed in the next ten years and beyond. The present situation, as shown in Fig.2.9, is indeed dismal indicating essentially the absence of highly qualified technical personnel in the present day task force of steel industry.

Table 2. 22(a) Characteristics of technical manpower division in steel plants in Japan.

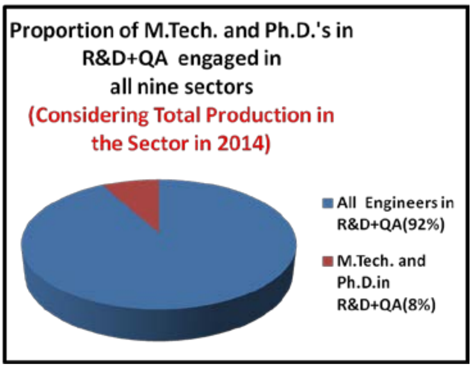
Nippon Steel + Sumitomo Metals Corporation	Total Engineers + Researchers	Total Engineers in production	Total Researchers	Others
25-30MMT	5000	3500	1000	500

Table 2. 22(b) Characteristics of technical manpower division in Indian steel industries (primary and secondary combined).

Steel industries in India	Total Engineers + Researchers	Total Engineers in production + maintenance etc.	Engineers in R&D+QA
78-81MMT	56189	52388	3801



(a)



(b)

Figure 2.9 Relative proportion of engineers in R&D and QA *vis a vis* the total number of engineers in production and (b) the number of doctorate and masters degree holders among engineers employed in the R&D and QA.

In the light of the above, it is important to have an idea of the number of researchers that would be necessary to manage R&D activities effectively in future steel industries in the country. Once again, the existing scenario in steel plants in Japan can be used as a reference to work out the relevant numbers. According to the lower bound estimates shown in Table 2.9, 28240 graduate engineers and 26892 diploma engineers shall be needed to manage modern and efficient steel plants of the country for producing 300 MTPA (primary and secondary sectors combined). Since 20% of the total engineers in any efficient steel plants are supposed to be researchers, this implies that eleven thousand twenty six [11026 (= 0.20x55132)] researchers shall be needed in the country to manage and sustain 300 MTPA of steel production. Furthermore, since of the total researchers, nearly 50% are expected to be metallurgists, this implies that approximately 5513 master and doctoral degree holders shall be needed over next ten years to run the domestic steel industries efficiently. Therefore, annual demand over the next ten years for master and doctoral degree holders in metallurgical engineering alone is nearly 550. Such estimates shall not change significantly since only a handful of master and Ph.D. degree holders have been shown to be currently employed in steel industries.Since the above mentioned figure has been arrived at from the lower bound considerations, this is the least that is required.

A web based survey of IITs and NITs as well as IISc. has indicated that presently not even 5 Ph.D.'s and 30 M.Tech.'s in the area of iron and steel metallurgy are produced in the country annually. As examples, IIT Kanpur since inception, during the last 60 years, has produced altogether 750 M.Tech. and 95 Ph.D.'s. Similarly, during the past ten years, in the area of iron and steel metallurgy, IIT BHU has produced 28 M.Tech.'s and 4 Ph.D.'s. Alarmingly, there are not even ten professors left in the academia who are truly specialized in iron and steel metallurgy! Given such, ensuring such a large number of M.Tech.'s and Ph.D.'s, needed to drive future, innovative domestic steel mills, is truly a challenging task. Search for a radically different paradigm is needed to address this critical issue.

3

Availability of technical manpower

3.1 Introduction

The chapter discusses the present status of technical education in the country, and makes an assessment of the likely availability of technical manpower from academic institutions based on current sanctioned intake for different types of institutions. The employability of fresh graduate engineers by the industry, based on their skill levels, is reviewed and the availability of graduate engineers suitably adjusted.

3.2 Growth of engineering/technical institutions

There has been a marked growth in the number of engineering institutes over the last few years. This has been largely due to the surge in demand for qualified technical manpower, in view of the industrial growth being witnessed by the country. The growth in the number of engineering institutions in the country between 2006-07 and 2013-14 is illustrated in Fig.3.1.

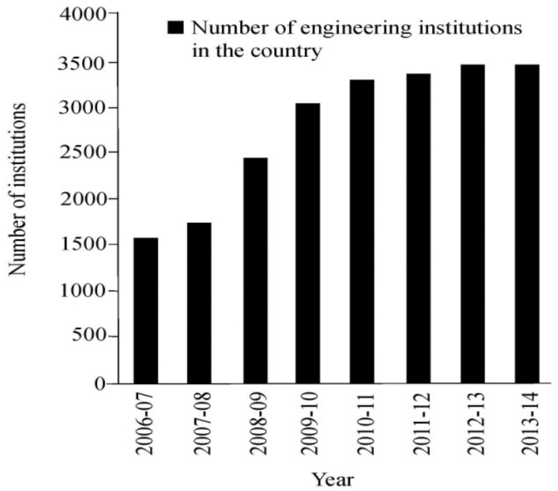


Figure 3.1 Growth in number of engineering institutions (Source: AICTE).

As a consequence of the growth in the number of technical institutions, the total sanctioned intake of under graduate students in the engineering institutes has also grown considerably in the past, as illustrated in Fig.3.2.

3.3. Availability of technical manpower from academic institutions

In order to assess the availability of engineers, diploma holders and ITI trained personnel across the country, interactions were held with many of the leading engineering institutes, as well as Government agencies. The Directorate of Employment & Training was contacted for information on availability of trained personnel from ITIs and ITCs. The publications and web site of All India Council of Technical Education (AICTE) were consulted for compiling the information.

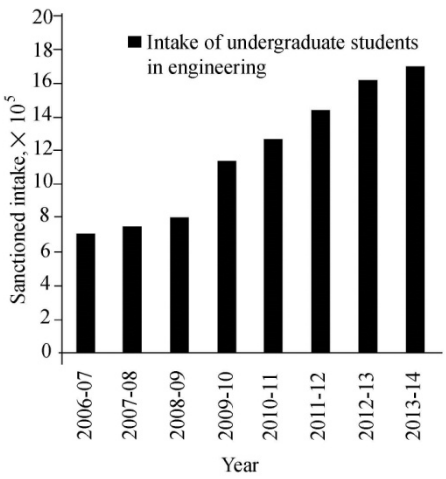


Figure 3.2 Growth in sanctioned intake of under graduate students (Source: AICTE).

3.3.1 Sanctioned intakes of under graduate and post-graduate students

The current sanctioned intakes of students in all disciplines at the under graduate and post-graduate levels, by the different institutions, are given in Table 3.1.

Table 3.1 Sanctioned intakes of under graduate and post graduate students (all disciplines)[15].

Institution	Under graduate		Post graduate		Total	
	Number	%	Number	%	Number	%
IITs	8,360	0.5	1,388	0.6	9,748	0.5
NITs	15,484	0.9	7,840	3.6	23,324	1.2
Others (1)	17,07,283	98.6	2,12,084	95.8	19,19,367	98.3
Total	17,31,127	100.0	2,21,312	100.0	19,52,439	100.0

From the above table it is observed that over 98 per cent of fresh graduates would be from institutes other that IITs and NITs. In the case of post graduates, contribution of IITs and NITs is somewhat higher (about 4 per

[15](1)From AICTE web site. Also, www.slideshare.net/anushrikocher/intake-of-iit-and-ism and csab.nic.in/csabseatinfo/root/BranchInst.aspx were consulted to construct the table.

cent). Out of these engineers, a very large proportion would graduates from private engineering institutes in Computer Science (CS) and Information Technology (IT) related disciplines. A comparison of the sanctioned intake of students from the Metallurgy and Materials Engineering stream, at the under graduate and post graduate levels in IITs, NITs and in other institutions is presented in Table 3.2.

Table 3.2 Sanctioned intake in Metallurgy and Materials Engineering (Source: AICTE).

Institution	Under- graduate		Post-graduate	
	Number	%	Number	%
IITs	479	16	246	24
NITs	804	27	308	31
Others	1,688	57	450	45
Total	2,971	100	1,004	100

From Table 3.2 it is seen that the combined sanctioned intake for IITs and NITs is almost similar to that for other institutions. This is quite different to the situation when considering all disciplines of engineering. A major reason for this is that not all institutions are able to provide the infrastructure and facilities required for teaching metallurgy and materials engineering. Table3.3 gives the breakup of current sanctioned intake of under graduate students in various disciplines.

Table3.3 Discipline-wise sanctioned intake of under graduate students.

Engineering discipline	Number of students			
	IITs	NITs	Others	Total
Metallurgy and Materials	479	804	1,688	2,971[16]
Mechanical, Production etc.	1,529	2,925	3,59,487	3,63,941
Electrical	1,118	2,081	2,17,727	2,20,926
Electronics, Instrumentation etc.	917	2,606	3,49,869	3,53,392
Chemical	1,220	1,106	10,877	13,203
Civil	1,128	2,081	2,53,445	2,56,654
Mining & Mineral	591	244	5,109	5,944
Ceramics	98	56	170	324
Comp. Sc. (CS) & IT	942	3,037	4,03,033	4,07,012
Others[17]	338	544	1,05,878	1,06,760
Total	8,360	15,484	17,07,283	17,31,127

[16]Numbers in the tables corroborate reasonably well with those obtained from other sources as well. For example in MT discipline the total number of examinees in GATE 2015 was 3745.

[17] This embodies, Environmental, Architecture, Automobile and other branches. For IITs and NITs, discipline-wise break-up is based on pattern in Table 12.02 of 2008 study. For 'Other' institutions, data has been compiled from the AICTE web site.

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Based on the discipline-wise breakup given in Table3.3, the summarized sanctioned intakes for CS & IT related disciplines as well as for non-CS & IT related disciplines are given in Table 3.4.

3.4 Availability of Graduate Engineers for steel industry based on sanctioned strength

On the basis of the discipline-wise sanctioned intake of under graduate students, which is expected to be a reasonable estimate of graduating engineers that will be annually available for employment, as given in Table3.3 earlier, an attempt has been made to assess the likely availability of graduate engineers for the steel industry. This has been done on certain considerations/assumptions, as listed out below, based on feedback obtained from some of the institutions regarding pattern of placement of their graduating students. To arrive at the relevant values, the following assumptions were invoked:

i) For graduates from CS & IT related streams, 80 per cent from IITs, NITs and other institutions will find placement in IT related sectors; 5 per cent graduates from IITs, and 10 per cent from NITs and other institutions will proceed for higher studies; balance 15 per cent from IITs, and 10 per cent from NITs and other institutions will join the core/manufacturing sectors, which includes the steel industry.

ii) For graduates from non CS & IT related streams, 55 per cent from IITs, NITs and other institutions will find placement in IT related sectors; 10 per cent graduates from IITs, and 20 per cent from NITs and other institutions will proceed for higher studies; balance 35 per cent from IITs, and 25 per cent from NITs and other institutions will join the core/manufacturing sectors, which includes the steel industry. The above considerations/assumptions are summarized in Table 3.5.

Table 3.4 Summarised sanctioned intakes of under graduate students.

Institutions	Number of students		
	CS & IT related disciplines	Non CS & IT related disciplines	Total
IITs	1,859	6,501	8,360
NITs	5,643	9,841	15,484
Others	7,52,902	9,54,381	17,07,283
Total	7,60,404	9,70,723	17,31,127

3.4.1 Estimated availability for steel industry

Based on the estimated likely total availability of graduate engineers from different disciplines, as given in Table 3.3 and the anticipated placement pattern given in Table 3.5, the likely availability of fresh engineering graduates, seeking employment in the steel industry, is presented in Table3.6. In estimating the availability, it is assumed that 40 per cent of graduates from Metallurgy & Materials Science and Mining & Mineral Engineering disciplines, and 25 per cent of graduates from all other disciplines, seeking employment in the core/manufacturing sectors, will opt for the steel industry.

Table3.5 Considerations/assumptions for estimating availability of graduate Engineers for steel industry.

Graduating Institutions	Placement		
	In IT and related sectors	For higher studies	In core or manuf. sectors
	CS & IT related disciplines		
IITs	80%	5%	15%
NITs & others	80%	10%	10%
	Non CS & IT related disciplines		
IITs	55%	10%	35%
NITs & others	55%	20%	25%

Table 3.6 Likely availability of graduate engineers for steel industry

Engineering discipline	% Deployment			Number[18]		
	In core or manuf. IITs	In core or manuf. NITs & others	In steel industry	From IITs	From NITs & others	Total
Metallurgy and materials	35	25	40	67	249	316
Mechanical, production etc.	35	25	25	134	22,651	22,785
Electrical	35	25	25	98	13,738	13,836
Electronics, Instrumentation etc.	15	10	25	34	8,812	8,846
Chemical	35	25	25	107	749	856
Civil	35	25	25	99	15,970	16,069
Mining & Mineral	35	25	40	83	535	618
Ceramics	35	25	25	9	14	23
CS & IT	15	10	25	35	10,152	10,187
Others (1)	35	25	25	30	6,651	6,681
Total				696	79,521	80,217

[18] Computed as (% in core/mfg sector) x (% in steel industry) x (sanctioned intake)

3.5 Employability of Graduate Engineers

3.5.1Findings of various studies

A number of studies have been carried out from time to time to assess the employability of fresh graduates from Indian institutions, including engineers. These include:

(i) The National Employability Report, Engineers, Annual Report 2014 by Aspiring Minds.

(ii) The India Skills Report 2014, jointly prepared by PeopleStrong, Wheebox and CII and

(iii) Employability and Skills of Newly Graduated Engineers in India, Policy Research Working Paper 5640 by World Bank, Washington DC.

The salient findings of these studies are summarized in Table 3.7. All the studies conclude that the skill sets and innovative qualities in the fresh graduates are generally far below the expectations of the prospective employers.

Table 3.7 Major findings of studies on employability.

Studies	Agency	Major findings
National Employability Report, Engineers, Annual Report 2014	Aspiring Minds	(i) About 50% engineers prefer software jobs; 45% core engineering jobs. (ii) Less than 20% engineers employable for software jobs; about 7% for core engineering jobs. (iii)Employability for top colleges ~80%; almost 40% colleges have employability below 11%.
The India Skills Report 2014	People Strong Wheebox CII	(i)Anticipated skill gap of 75-80% across industry sectors. (ii)In age group 18-29 years, employability varied between 40% and 20%. (iii)Employability of BE/BTech ~52%; BSc ~42%; ITI ~47%; Polytechnics ~12%.
Employability and Skills of Newly Graduated Engineers in India, *Policy Research Working Paper 5640*	World Bank, Washington, DC	(i) Shortage of skills a major constraint to continued growth of economy. (ii) Employers complain new graduate engineers lack suitable skills. (iii) Engineering schools should focus more on higher order skills and creativity in graduates.

3.5.2 Yearly effective intake of under graduate students adjusted for 'employability'

Based on the above mentioned findings in respect of employability of fresh graduates, the sanctioned intakes have been adjusted downwards adopting the following 'employability factors which are summarised in Table 3.8 below':

Table 3.8 Employability factor considered in this work.

Source institution	Discipline	Employability factor[19]
IITs	All disciplines	90%
NITs	All disciplines	70%
Others	Metallurgy	70%
	Others	50%

Adopting the above 'employability factors', the discipline-wise adjusted intakes of under graduate students are presented in Table 3.9.

Table3.9 Discipline-wise 'effective' intake of under graduate students (adjusted for employability)[20].

Engineering discipline	Number of students			
	IITs(1)	NITs(1)	Others(1)	Total
Metallurgy and materials	431	563	1,182	2,176
Mechanical, Production etc.	1,376	2,048	1,79,744	1,83,168
Electrical	1,006	1,457	1,08,864	1,11,327
Electronics, Instrumentation, etc.	825	1,824	1,74,935	1,77,584
Chemical	1,098	774	5,439	7,311
Civil	1,015	1,457	126,723	1,29,195
Mining & Mineral	532	171	2,555	3,258
Ceramics	88	39	85	212
Computer Sc. & IT	848	2,126	2,01,517	2,04,491
Others	304	381	52,939	53,624
Total	7,523	10,840	8,53,983	8,72,346

[19] % of sanctioned intake

[20] (1) Computed as (Sanctioned intake) x (Employability factor)

Table3.10 Placement patterns from all engineering colleges/institutions for two distinct categories of students viz., CS and IT related as well as non-CS and IT related disciplines.

Graduating Institutions	Placement		
	In IT related sectors	For higher studies	In core or manuf. sectors
	CS & IT related disciplines		
IITs, NITs and others	80%	5%	15%
	Non CS & IT related		
IITs, NITs and others	55%	10%	35%

3.5.3 Estimated availability for steel industry considering employability of fresh graduates

Based on the 'effective' intakes given in Table 3.9 above, the likely availability of graduate engineers for the steel industry is given in Table3.11. In doing so, the placement pattern considered is summarised in Table 3.10.It is to be noted that the placement patterns for IITs, NITs and other institutions have been taken as similar for each broad stream of study since the sanctioned intakes have been suitably adjusted for employability.

Table 3.11 Likely availability of graduate engineers for steel industry (adjusted for employability)

Engineering discipline	% Deployment			Number[21]		
	In core or manuf. IITs	In core or manuf. NITs & others	In steel industry	From IITs	From NITs & others	Total
Metallurgy and Materials	35	35	40	60	244	304
Mechanical , production etc.	35	35	25	120	15,907	16,027
Electrical	35	35	25	88	9,653	9,741
Electronics, Instrumentations etc.	15	15	25	31	6,628	6,659
Chemical	35	35	25	96	544	640
Civil	35	35	25	89	11,216	11,305
Mining & Mineral	35	35	40	74	382	456
Ceramics	35	35	25	8	11	19
CS & IT	15	15	25	32	7,637	7,669
Others (1)	35	35	25	27	4,665	4,692
Total				625	56,887	57,512

[21] Computed as (% in core/mfg sector) x (% in steel industry) x (effective intake)

3.5.4 Range of availability of Graduate Engineers

The likely availabilities of graduate engineers for the steel industry based on sanctioned intake, and after factoring in 'employability' of fresh graduates, are compared in Table 3.12.

Table 3.12 Range of availability of graduate engineers.

Engineering discipline	Range of availability	
	Based on sanctioned intake only	Considering employability aspect
Metallurgy and Materials	316	304
Mechanical, Production etc.	22,785	16,027
Electrical	13,836	9,741
Electronics, Instrumentations etc.	8,846	6,659
Chemical	856	640
Civil	16,069	11,305
Mining & Mineral	618	456
Ceramics[22]	23	19
Comp. Sc. (CS) & IT	10,187	7,669
Others	6,681	4,692
Total	80,217	57,512

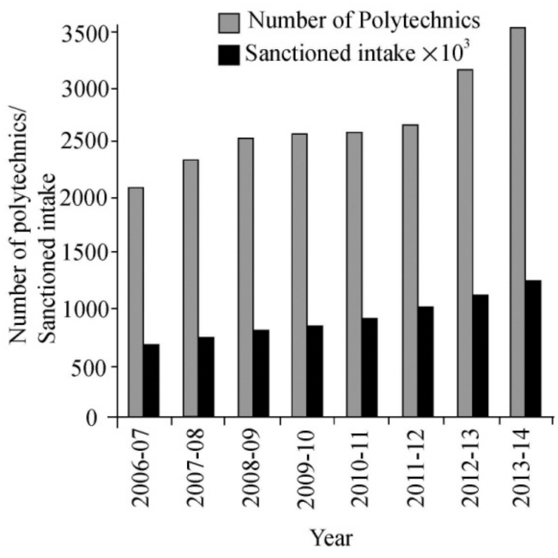

Figure 3.3 Growth of polytechnics and sanctioned intake (Source: AICTE)

[22] An independent feedback obtained from college of glass and ceramic engineering Kolkata, puts the figure at 50.

3.6 Polytechnic Institutes

3.6.1 Growth of Polytechnics

In keeping with the spurt in demand for qualified diploma holders in engineering, AICTE has been approving the setting up of new polytechnic institutes. Fig.3.3 illustrates the growth in the number of polytechnic institutes and their corresponding sanctioned number of intakes between 2006-07 and 2013-14.

The current sanctioned intake is 11.35 lakh. The discipline-wise breakup of sanctioned intake is given in Table 3.13.

Table 3.13 Sanctioned intake in polytechnics (Source: AICTE).

Engineering discipline	Number	%
Civil	2,83,795	25
Mechanical	2,83,795	25
Electrical, IT, Electronics & Telecommunications	3,40,554	30
Others including Metallurgy	2,27,035	20
Total	11,35,179	100

3.6.2 Availability of diploma holders for steel industry

Considering the discipline-wise sanctioned intake given in Table 3.13 and factoring in the level of employability indicated in the study 'The India Skills Report 2014', the likely availability of diploma holders for the steel industry is given in Table 3.14.

Table 3.14 Likely availability of diploma holders for steel industry.

Engineering discipline	Number	
	Sanctioned intake	Likely availability
Civil	2,83,795	34,055
Mechanical	2,83,795	34,055
Electrical, IT, Electronics & Telecommunications	3,40,554	40,866
Others including Metallurgy	2,27,035	27,244
Total	11,35,179	1,36,220

3.7 Industrial Training Institutes

As per the Annual Report 2013-14 of the Ministry of Labour & Employment, Government of India, there are 10,750 Government and private ITI's in the country, with a sanctioned intake of 15,23,696. Of the total intake, 50 per cent is reserved for women, disabled, Defence personnel and OBCs. It is anticipated that only 25 per cent of the sanctioned intake (i.e.,3,80,924) relates to disciplines that are relevant for the steel industry.

4

Consolidation: observations, deliberations and recommendations

4.1 Introduction

Estimation of requirement and availability of technical manpower for the future is complex. Future prediction, as such, is difficult and often turns out to be far from the reality. In chapters 2 and 3, based on data collected from industry and academic bodies and their consequent rationalisation, an attempt has been made to deduce relevant numbers to address requirement and availability of technical manpower with reference to domestic steel industries in the country. Various assumptions as well as uncertainties associated with the exercise have been stated explicitly. Because of the complexity of the issue at hand, it was further decided to discuss and deliberate the entire exercise (essentially the contents of Chapters 2 and 3) in an expert group such that outcome from the study can be presented in a meaningful manner to essentially benefit government agencies, industries and academia, concerned with steel production and education. In the following, results of the deliberations are presented. This can be summarily taken as the conclusions and recommendations from the present study. Beyond such, as pointed out in subsequent sections, many interesting view points and different perspectives of the complex problem followed, which are also summarised to help future shaping of steel industries and academic institutions in the country.

4.2. Deliberation on manpower requirement, availability, analysis and results

Results presented in Chapters 2 and 3 have indicated that in comparison to the annual requirement of graduate/diploma engineers in steel industry, almost all engineering disciplines in undergraduate program attract considerably more number students every year. However, all students graduating from any particular discipline are not available for immediate employment because of different reasons and these for example include, personal ambitions as well as various socio-economic reasons. Once various factors are included in the analysis through a suitable “employability factor”, available number of graduate engineers for steel industries can be computed It is thus found out that substantially smaller numbers are actually available (particularly for materials and metallurgy for which the availability is roughly 10% of the intake). Results presented in Chapters 3 and 4 have also indicated that if future steel plants embody modern technology and automation, no shortfall of graduate engineers for any discipline is likely. This follows since the lower bound numbers shown in Table 2.19 are smaller than the computed effective availability of graduate/diploma engineers shown in Tables 3.12 and 3.14 respectively. In contrast, if steel mills continue to remain as these are today and do not modernize as expected, there is likely to be some shortfall in the supply of graduate metallurgical engineers (compare for example the numbers shown in Tables 2.18 and 3.12) and to some extent, for ceramic engineers.

To address the above and to analyse critically various related issues, a brain storming session was conducted at IIT Kanpur on the 13th of April, 2015 involving various stake holders. In this meeting, key personnel from steel industries (integrated and secondary sectors), academia, R&D laboratories, manufacturing associations etc. were invited. Altogether 28 personnel from various quarter attended the meeting to deliberate the exercise carried out at IIT Kanpur since August 2014. A list of participating members together with their affiliation is summarized in Appendix V. During the meeting the co-investigator made a detailed presentation (see Fig.4.1). Several suggestions were advocated by members and these were subsequently embodied in the study to improve the accuracy and quality of the present exercise.

Figure 4.1 A moment captured photographically during the brainstorming session held at IIT Kanpur on the 13th of April, 2015.

4.3. Summary of observations and recommendations:

The entire work on the subject of requirement and availability of technical manpower for domestic steel industries was deliberated extensively for a full day. Numerous observations and recommendations have been made. The generally agreed observations /conclusions from the study are summarised in the following:

(i) Based on employability, although a gap between requirement and availability of B.Tech./BE in Metallurgical engineering was shown to exist, practically all members opined that the gap is more in terms of knowledge than numbers. It was noted that the number of engineers graduating in metallurgical engineering is far more than the yearly required numbers for the steel and allied industries combined. It is unfortunate that a very small number of graduating students take up career in steel industries.

(ii) It is suggested that, with curriculum in many institutions tilting towards materials science and engineering, the component of process /extractive metallurgy has decreased significantly over the years. To reverse the effect of such changes, educational institutes should engage experts from industry as adjunct professors who could offer and teach, from time to time, tailored made elective courses on plant relevant topics. Such endeavour, in turn, is likely to bridge the gap in knowledge that exists currently in graduating engineers, particularly in the discipline of metallurgical engineering. In general, expectations of steel plants are not fulfilled to a large extent from currently available metallurgical engineering graduates in the country. Industry relevant subjects such as automation, emission and environment must also be emphasized in the metallurgical engineering curricula to make engineers more relevant to the metals processing industry.

(iii) Metallurgical engineers find it less attractive to join steel processing and allied industries following graduation. Compensation package, harsh industrial environment, plant location etc. are some of the issues of concern and key factors that tend to discourage graduating students from making a career in steel plants. Furthermore, for metallurgical engineers, there is not much scope to flourish in the plant. These are also important factors in the retention of newly recruited engineers in steel plants. It is suggested that job content and compensation packages be improved to attract and retain bright minds. Steel plants must play a proactive role in this direction.

(iv)Undergraduate projects relevant to steel industry must be offered to students to increase interest and creativity among metallurgical engineering students. Paid summer internship programs must be vigorously pursued. In addition to these, teachers must be exposed to industry so that knowledge can be imparted in the class room more realistically and effectively. Similarly, deferred learning or participation of practicing engineers in continuing education program is a must such that full potential of "theory assisted practice" could be exploited on the shop floor.

(v) In view of the large attrition rate as well as unwillingness on the part of technically qualified personnel (mostly graduate engineers) to join steel industry, it is advocated that new, model polytechnics and ITI's be located in the vicinity of steel plants. These can balance technical manpower supply to steel plants somewhat.

(vi) Although quality/skill of pass outs from polytechnics and ITI's is a general matter of concern to steel industries, such technical personnel should be, as a routine, imparted practical training on shop floor prior to their full deployment in the task force. It is suggested that National Skill Development Council (NSDC) established by the

Govt. India is likely to fill this gap and thereby enhance the quality of polytechnic and ITI pass outs further, who could effectively contribute to the prosperity of steel industries.

(vii) Steel plants in India tend to be managed by more mechanical than metallurgical engineers. Unless we become an innovative steelmaking nation, such a trend is likely to continue since to sustain daily production by smooth running of various machineries, large number of mechanical and electrical engineers are generally required. It is suggested that significant and meaningful R&D actives in the plant as well as a change in the aspiration of the management can alter the prevailing scenario to a large extent.

(viii) Steel plants in India in general do not tend to nurture research and development activities. Barring routine inspection and quality jobs, hardly a handful of engineers are engaged in R&D activities. Often expectations from R&D personnel are also not spelt out. To this end it is pointed out that a large number of M.Tech.'s and Ph.D.'s in iron and steel metallurgy are not presently available in the country. Furthermore, he quality of mater and Ph.D students are often not up to the mark. As there is no additional incentive in joining R&D, relatively bright students are naturally reluctant towards making a career in R&D in steel plant. The situation aggravates since technical personnel working in production are generally given relatively more attention/importance. Finally, R&D and plant personnel rarely work together, hand in hand, making researchers in steel plants look somewhat irrelevant. Industry must take a proactive role to make plant R&D more relevant and attractive.

(ix) While industries have to change aspiration from a mere money making establishment to an "innovative, money making set up", existing academic institutes must also be strengthen to bolster R&D activities in iron and steel metallurgy. To this end, Industry and government must come forward to support academic institutions in terms of industry oriented projects, manpower, equipment etc. Certainty in post education employment is important and is likely to make such efforts more attractive.

(x) Setting up of a graduate school in ferrous metallurgy on the same line as POSTECH can help generate more master and doctorates needed to effectively serve steel plant R&D. However, the concept may be difficult to work out given that country is presently lacking a critical manpower in iron and steel metallurgy, required to initiate such ambitious projects and bring it to fruition.

In summary, the discussion points out that academia, industry and the Ministry of Steel have many important roles to play and must collectively make decisive efforts in many fronts in order to change the existing scenario. Well defined area of improvements for stake holders have been enumerated and highlighted above.

APPENDIX I

Members of various committees constituted to execute the present work

A. Core committee

Member	Affiliation	Area of expertise
Dr.Indranil Manna	IIT, Kanpur	Education & Metallurgy
Dr. Dipak Mazumdar	IIT, Kanpur	Education and Metallurgy
Dr.T Venugopal	Tata Steel	Iron and Steel and manpower
Dr.Vinay K.Gupta	RDCIS, SAIL	Mineral processing
Dr. Arup Ghosh	CGCRI, Kolkata	Refractory
Mr.R.K.Bagchi	NISST, Govindgarh	Metallurgy/industry/ education
Mr. Sushim Banerjee	INSDAG, Kolkata	Metallurgy/manpower
Mr. D.Kashiva	Sponge iron manufacturers association (SIMA)	Metallurgy/Sponge iron

B. Project committee

Member	Affiliation	Area of expertise
Dr. Dipak Mazumdar	IIT Kanpur	Education and Metallurgy
Dr.Amarendra Singh	IIT Kanpur	Iron and Steel
Mr.Saktimoy Ghosh	JSPL	Iron and Steel
Mr.Bhaskar Roy	IIM	Manpower

C. Expert committee

Name	Affiliation
Dr. Baldev Raj	President INAE, Former President IIM
Dr. Sanak Mishra	Vice president INAE; Former President IIM
Dr. T.Mukherjee	Former DMD, Tata Steel: Former President IIM
Dr. Subir Bhattacharya	Former ED, SAIL RDCIS; Former President IIM
Mr. R.N.Parbat	Former President , IIM
Mr. Sashi Sekhar Mohanty	Director (Technical) SAIL;Vice President IIM
Dr. Srikant	Director NML, Jamshedpur
Mr. A.C.R.Das	Advisor, Ministry of Steel, New Delhi

APPENDIX II

Questionnaires for steel and allied industries

A. Questionnaire for steel industry

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

3. Installed capacity (crude steel) in million tonnes

4. Product mix

5. Actual production of crude steel in FY. 2013-14 in million tonnes

6. Process route

7. Automation level (with bulleted brief descriptions)

8.Total manpower[23] in the organization as of April 1st, 2014[24]

9.Activities and manpower outsourced

[23] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.

[24] Excluding school, township management as well as other social services.

10.Entry level salary range for engineers

11. Total technical manpower in the company's pay roll as of 1st April, 2014

Engineer & technician	Mech. Engg.	Electr. Engg.	Chem. Engg.	Mineral Engg.	Metall. Engg.	Civil Engg.	IT & CSE	Environ. Engg.	Ceramic Engg.	Others	Total
ITI certificate holders											
Diploma holders											
B.Sc./M.Sc.											
B.Tech. or equivalent											
M.Tech.											
Ph.D.											

12. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

13. Technical manpower evolution statistics over the last five years

Year	FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower					
Total production in million tonnes					
Installed capacity in million tonnes					

14. Technical manpower (included already in item 11) in R&D laboratory, Quality assurance deptt. and automation

Engineers & Researchers	Metallurgical Engg.	Other disciplines combined
B.Sc./M.Sc./Diploma holders		
B.Tech.		
M.Tech.		
Ph.D.		

15. Future capacity enhancement statistics

Year	Up to 2020	For the period 2020-2030
Projected capacity in million tonnes		
Projected technology up-gradation/New Technology		

16. Any other relevant information that you would like to add to make the survey more effective (Please attach sheet if necessary)

B. Questionnaire for Sponge Iron plants

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

3. Area of activity (Tick appropriate ones)

I. Sponge iron	ii. Beneficiation	iii.Captive power plant (CPP)

4. Installed capacity

I. Sponge iron (in million tonnes)	ii. beneficiation (in million tonnes)	iii.CPP (MW)

5. Actual production in FY. 2013-14

I. Sponge iron (in million tonnes)	ii. beneficiation (in million tonnes)	iii.CPP(MW)

6. Process route (Tick one)

Coal based / gas based/ others

7. Automation level (with bulleted brief descriptions)

8. Total manpower[25] in the organization as of April 1st, 2014[26]

9.Activities and manpower outsourced

10.Entry level salary range for engineers

[25] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.
[26] Excluding school and township management as well as other social services.

11. Total technical manpower in the company's pay roll as of 1st April, 2014

Engineers & technicians	Mech. Engg.	Electr. Engg.	Chemical Engg.	Metallurgical. engineering	Civil Engg.	IT	Environ. Engg.	Mineral engg.	Others	Total
ITI certificate holders										
Diploma holders										
B.Sc./M.Sc.										
B.Tech. or equivalent										
M.Tech.										
Ph.D.										

12. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

12. Technical manpower evolution statistics over the last five years

Year	FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower					
Total production in million tonnes					
Installed capacity in million tonnes					

13. Technical manpower (Included already in item 11) in R&D laboratory, Quality assurance dept. and automation

Engineers & Researchers	Metallurgical Engg.	Other disciplines combined
B.Sc./M.Sc./Diploma holders		
B.Tech.		
M.Tech.		
Ph.D.		

14. Future capacity enhancement statistics

Year		Up to 2020	For the period 2020-2030
Projected capacity in million tonnes/MW	Sponge iron		
	Beneficiation		
	CPP		
Projected technology up-gradation/New Technology/Innovations			

15. Any other relevant information that you would like to add to make the survey more effective

C. Questionnaire for Merchant pig iron industries

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

4. Area of activity

3. Installed capacity in thousand/ lakh tonnes

5. Total actual production of pig iron alloy in FY. 2013-14 in thousand / lakh tonnes

6. Process route

7. Total manpower[27] in the organization as of April 1st, 2014[28]

8. Total technical manpower in the company's pay roll as of 1st April, 2014

Engineers & technicians	Mech. Engg.	Electr. Engg.	Chemical Engg.	Metall. Engg.	Civil Engg.	IT/CSE	Environ. Engg.	Mineral Engg.	Others	Total
ITI certificate holders										
Diploma holders										
B.Sc./M.Sc.										
B.Tech. or equivalent										
M.Tech.										
Ph.D.										

9.Activities and manpower outsourced:

[27] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.
[28] Excluding school and township management as well as other social services.

10. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

11. Technical manpower evolution statistics over the last five years

Year	FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower					
Total production in thousand tonnes					
Installed capacity in thousand tonnes					

12. Technical manpower (included already in item 9) in R&D laboratory, Quality assurance deptt. and automation

Engineers & Researchers	Metallurgical Engg.	Other disciplines combined
B.Sc./M.Sc./Diploma holder		
B.Tech.		
M.Tech.		
Ph.D.		

13. Future capacity enhancement statistics

Year	Up to 2020	For the period 2020-2030
Projected capacity in thousand / lakh tonnes		
Projected technology up-gradation/New Technology		

14. Any other relevant information that you would like to add to make the survey more effective

D. Questionnaire for Rolling Mills, re-rolling mills and coating units

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

3. Product mix (Tick appropriate ones)

I. HR long	ii. HR flats	III. CR	iv. Coated

4. Item wise Installed capacity in thousand (000) tonnes

I. HR long	ii. HR flats	III. CR	iv. Coated

5.Itemwise actual production in FY. 2013-14 in thousand (000) tonnes

I. HR long	ii. HR flats	III. CR	iv. Coated

6. Automation level (with bulleted brief descriptions)

7. Total manpower[29] in the organization as of April 1st, 2014[30]

8. Total technical manpower in the company's pay roll as of 1st April, 2014:

Engineers & technicians	Mech. Engg.	Electr. Engg.	Metallurg. Engg.	Civil Engg.	Environ. Engg.	Others	Total
ITI certificate holders							
Diploma holders							
B.Sc./M.Sc.							
B.Tech. or equivalent							
M.Tech.							
Ph.D.							

[29] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.

[30] Excluding school and township management as well as other social services.

9.Activities and manpower outsourced

10. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

11. Technical manpower evolution statistics over the last five years

Year		FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower						
Total production in '000 tonnes	HR long					
	HR Flats					
	CR					
	Coated					
Installed capacity in '000 tonnes	HR long					
	HR Flats					
	CR					
	Coated					

12. Technical manpower (Included already in item no.9) in R&D laboratory, Quality assurance deptt. and automation

Engineers & Researchers	Metallurgical Engg.	Other disciplines combined
B.Sc./M.Sc./Diploma holders		
B.Tech.		
M.Tech.		
Ph.D.		

13. Future capacity enhancement statistics

Year		Up to 2020	For the period 2020-2030
Projected capacity in '000 tonnes	HR long		
	HR flat		
	CR		
	Coated		
Projected technology up-gradation/New Technology			

14. Any other relevant information that you would like to add to make the survey more effective

E. Questionnaire for Refractory industries

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

3. Product ranges (Tick as appropriate)

I. Monolithic	II. Shaped

4.Itemwise Installed capacity in thousand/lakh tonnes

I. Monolithic	II. Shaped

5.Itemwise Actual production in FY. 2013 in thousand /lakh tonnes

I. Monolithic	II. Shaped

6. Total manpower[31] in the organization as of April 1st, 2014[32]

7.Activities and manpower outsourced

8. Total technical manpower in the company's pay roll as of 1st April, 2014:

Engineers & technicians	Mech. Engg.	Electr. Engg.	Chemical Engg.	Mineral Engg.	Metallurgical. engineering	Ceramic engg.	Others	Total
ITI certificate holders								
Diploma holders								
B.Sc./M.Sc.								
B.Tech. or equivalent								
M.Tech.								
Ph.D.								

[31] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.

[32] Excluding school and township management as well as other social services.

9. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Ceramic Engineering Graduates						
Ceramic Engineering Diploma holders						
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

10. Technical manpower evolution statistics over the last five years

Year		FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower						
Total production in thousand/lakh tonnes	Monolithic					
	Shaped					
Installed capacity in thousand/lakh tonnes	Monolithic					
	Shaped					

11. Technical manpower (included already in item No.8) in R&D laboratory, Quality assurance deptt. and automation

Engineers & Researchers	Ceramic engg.	Metallurgical Engg.	Other disciplines combined
B.Sc./M.Sc./Diploma Holders			
B.Tech.			
M.Tech.			
Ph.D.			

12. Future capacity enhancement statistics

Year		Up to 2020	For the period 2020-2030
Projected capacity thousand/lakh tonnes	Monolithic		
	Shaped		
Projected technology up-gradation/New Technology			

13. Any other relevant information that you would like to add to make the survey more effective

F. Questionnaire for mineral beneficiation industries

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

3.Area of activity (Tick as appropriate)

I Iron ore beneficiation	II. Pelletisation

4. Installed capacity in million tonnes

I Iron ore beneficiation	II. Pelletisation (throughput)

5. Actual amount of beneficiation I million tones in FY. 2013-14

I Iron ore beneficiation	II. Pelletisation (output)

6. Process route

7. Total manpower[33] in the organization as of April 1st, 2014[34]

8. Total technical manpower in the company's pay roll as of 1st April, 2014

Engineers & technicians	Mech. Engg.	Electr. Engg.	Chemical/ Engg.	Metallurgical. engineering	Civil Engg.	Mineral Engg.	Environ. Engg.	Ceramic Engg.	Others	Total
ITI certificate holders										
Diploma holders										
B.Sc./M.Sc.										
B.Tech. or equivalent										
M.Tech.										
Ph.D.										

9.Activities and manpower outsourced:

[33] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.
[34] Excluding school and township management as well as other social services.

10. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Mineral engineering graduates						
Mineral engineering diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

11. Technical manpower evolution statistics over the last five years

Year		FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower						
Total production in million tonnes	Beneficiation					
	Pelletisation					
Installed capacity in million tonnes	Beneficiation					
	Pelletisation					

12. Technical manpower (Included already in item 9) in R&D laboratory, Quality assurance deptt. and automation

Engineers & Researchers	Metallurgical Engg.	Mineral Engineering	Other disciplines combined
B.Sc./M.Sc./Diploma Holders			
B.Tech.			
M.Tech.			
Ph.D.			

13. Future capacity enhancement statistics:

Year		Up to 2020	For the period 2020-2030
Projected capacity in million tonnes	Beneficiation		
	Pelletisation		
Projected technology up-gradation/New Technology			

14. Any other relevant information that you would like to add to make the survey more effective

G. Questionnaire for Ferroalloy plants

1. Name of the Industry

2. Name of contact person; contact number and e-mail address

4. Area of activity

Ferroalloy types produced (Tick one or more) : FeMn, FeSi, SiMn, FeCr

3. Installed capacity in thousand tonnes

I. FeMn	II.FeSi	III.SiMn	IV.FeCr

5. Total actual production of ferro alloy in FY. 2013-14

I. FeMn	II.FeSi	III.SiMn	IV.FeCr

6. Total manpower[35] in the organization as of April 1st, 2014[36]

7. Total technical manpower in the company's pay roll as of 1st April, 2014:

Engineers & technicians	Mech. Engg.	Electr. Engg.	Chemical engg.	Metall. Engg.	Civil Engg.	IT/CSE	Environ. Engg.	Mineral Engg.	Others	Total
ITI certificate holders										
Diploma holders										
B.Sc./M.Sc.										
B.Tech. or equivalent										
M.Tech.										
Ph.D.										

8.Activities and manpower outsourced:

[35] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.

[36] Excluding school and township management as well as other social services.

9. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

12. Technical manpower evolution statistics over the last five years

Year	FY 2013	FY 2012	FY 2011	FY 2010	FY 2009
Total technical manpower					
Total production in thousand tonnes					
Installed capacity in thousand tonnes					

13. Technical manpower (included already in item 8) in R&D laboratory, Quality assurance deptt. and automation

Engineers & Researchers	Metallurgical Engg.	Other disciplines combined
B.Sc./M.Sc./Diploma holder		
B.Tech.		
M.Tech.		
Ph.D.		

14. Future capacity enhancement statistics

Year	Up to 2020	For the period 2020-2030
Projected capacity in thousand tonnes		
Projected technology up-gradation/New Technology		

15. Any other relevant information that you would like to add to make the survey more effective

H. Questionnaire for Service, Design and R&D organisation

1. Name of the Organization

2. Name of contact person; contact number and e-mail address

3. Industrial Sectors to which services are extended

4. Types of services extended

5. Proportion of services extended to Iron and steel and allied industries (such as mineral beneficiation, coke making, iron and steel making, smelting reduction, rolling mills, sponge iron production, material development etc.):

6. Total manpower[37] in the organization as of April 1st, 2014[38]

7. Entry level Qualification and salary range for engineers

[37] To include personnel in pay roll, associate employees and contracted personnel (involved in mineral beneficiation to finished steel product inside and outside the factory premises.
[38] Excluding school and township management as well as other social services.

8. Total technical manpower in the company's pay roll as of 1st April, 2014

Engineer & technician	Mech. Engg.	Electr. Engg.	Chem. Engg.	Mineral Engg.	Metall. Engg.	Civil Engg.	IT & CSE	Environ. Engg.	Ceramic Engg.	Others	Total
ITI certificate holders											
Diploma holders											
B.Sc./M.Sc.											
B.Tech. or equivalent											
M.Tech.											
Ph.D.											

9. Yearly data of required number of technical personnel and actual number joining

Category	FY 2014		FY 2013		FY 2012	
	Required	Joined	Required	Joined	Required	Joined
Metallurgical Engineering Graduates						
Metallurgical Engineering Diploma holders						
Other discipline graduates (all combined)						
Other discipline diploma holders (all combined)						

10. Future growth programs in terms of manpower and area of expertise

Year	Up to 2020	For the period 2020-2030

11. Any other relevant information that you would like to add to make the survey more effective (Please attach sheet if necessary)

I. Questionnaire for educational institutes

1. Name of the Institute/university /college

2. Contact person, cell number and e-mail address

3. Current UG and PG intake

UG (Total):	UG (Met):	M.tech.Total) :
M.Tech. (Met.)	Ph.D.(Total)	Ph.D.(Met)

4. Current yearly number of graduating engineers

UG (Total):	UG (Met):	M.tech.Total) :
M.Tech. (Met.)	Ph.D.(Total)	Ph.D.(Met)

5. Existing disciplines and seat distributions

Level	Mechanical	Electrical	Matls &Met.	Chemical	IT & CSE	Ceramics	Civil & environmental	Others
UG								
M.Tech.								
Ph.D.								

6. PG research students currently working in the area of iron and steel

M.Tech.	Ph.D.

7. Number of compulsory courses in the UG curriculum and their title (mention those only in the in the area of Metallurgical Engg.)

8. Discipline wise graduating engineers and corresponding number getting employed in the Iron and steel as well as , manufacturing sector:

(i) Number of students graduating yearly:

Level	Mechanical			Electrical			Metallurgical			Ceramic			Others		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
UG															
M.Tech.															
Ph.D.															

(i) Number of students getting employed in different sectors

Level	Iron and Steel			Manufacturing			Others		
	2012	2013	2014	2012	2013	2014	2012	2013	2014
UG									
M.Tech.									
Ph.D.									

9. Any other relevant information that you would like to add to make the survey more effective

APPENDIX III

List of organisations who were contacted for feed back

Integrated steel plants		
No.	Name	Address/location
01	Jindal Steel and Power, Raigarh	Chhattisgarh
02	Jindal South West steel Co., Belary	Karnataka
03	Bhusan steel, Dhenkanal	Odisha
04	Rashtriya Ispat Nigam Ltd., Vishakhapatnam	Visakhapatnam
05	Alloy Steel Plant, Durgapur	West Bengal
05	Durgapur Steel Plant, Durgapur	Durgapur, West Bengal
07	Tata Steel, Jamshedpur	Jamshedpur
08	Bhusan Steel, Sundergarh, Orissa	Odisha
09	Bokaro Steel Plant, Bokaro	Jharkhand
10	Rourkela Steel Plant, Rourkela	Rourkela
11	Bhilai Steel Plant, Bhilai	Chhattisgarh
12	IISCO, Burnpur	West Bengal
13	Essar Steel, Hazira	Gujarat
14	JSW, Dolvi	Maharashtra
Alloy steel plants		
No.	Name	Address/location
01	Jindal Stainless Steel, Hissar	Haryana
02	Adhunik Metalliks, Sundergarh	Odisha
03	Mahindra Sanyo Special Steels, Khopoli	Maharashtra
04	Usha Martin Co., Jamshedpur	Jharkhand
05	Kalyani Carpenter Special Steels, Pune	Pune, Maharashtra
06	Mukand Steel, Mumbai	Maharashtra
07	MESCO	Odisha
08	Nalwa Sponge, Raigarh	Raigarh
09	Sunflag Iron and Steel	Maharashtra
10	SISCOL	Tamil Nadu
11	Bhadravati Iron and Steel Limited	Karnataka

12	Salem Steel Plant	Tamil Nadu
13	Uttam Value Steels, Wardha	Maharashtra
14	Vardhaman Special Steels & Castings	Ludhiana, Punjab
15	Upper India Special Castings Limited	Ludhiana, Punjab
16	SMS Concast Engg.(I) Pvt.Ltd.	Pune
17	Remi steel Gujrat	Gujarat
18	Monet Ispat and power, Raipur	Chhattisgarh
19	Monet Ispat and power, Raigarh	Raigarh – 496 661, Chhattisgarh
20	Neco Jaiswal, Raipur	Chhattisgarh
21	Viraj Profiles, Mumbai	Maharashtra
22	Bajrang Ispat, Raipur	Raipur
23	L&T Special Steels, Hazira	Gujrat
24	Hospet steels, Ginigera	Ginigera, Karnataka
25	BMM Ispat, Hospet	Hospet , Karnataka
	Induction furnace based steel plants	
No.	Name	Address/location
01	A K Alloys Pvt. Ltd.	Punjab
02	A K Multi metals Pvt. Ltd.	Punjab
03	A K P Foundries Pvt. Ltd.	Karnataka
04	A K S Alloys Pvt. Ltd.	Puducherry
05	A M Ispat Ltd.	Gujarat
06	A One Ispat Pvt. Ltd.	Andhra Pradesh
07	A P S Associates Pvt. Ltd.	Punjab
08	A P Steel Re-Rolling Mill Ltd.	Kerala
09	A R Castings	Punjab
10	A R Metallurgical Pvt. Ltd.	Krishnagiri, Tamil Nadu
11	A R S Metals Pvt. Ltd.	Chennai, Tamil Nadu
12	A V Valves Ltd.	Uttar Pradesh
13	Aarti Steel Ltd. - Punjab	Punjab
14	Abhishek Alloys Pvt. Ltd.	Karnataka
15	Accurex Steel Rolling Mills	Haryana
16	Addi Alloys Pvt. Ltd.	Punjab
17	Adithya Ferro Alloys Ltd.	Puducherry
18	Aditya Pipes and Strips Pvt. Ltd.	Punjab
19	Agarwal Foundry	Telangana
20	Agarwal Induction Furnace Pvt. Ltd.	Andhra Pradesh

21	Agarwal Ispat Udyog	Karnataka
22	Agni Steels Pvt. Ltd.	Erode, Tamil Nadu
23	Jagdamba Ispat	Rajasthan
24	Jagdambay Concast Pvt Ltd.	Punjab
25	J R Ispat Pvt. Ltd.	Gujarat
26	Juneja Casting Pvt. Ltd.	Punjab
27	Jothi Melters (India) Pvt. Ltd.	Tamil Nadu
28	JPEE Alloys	Tamil Nadu
29	Jogindra Castings Pvt. Ltd.	Punjab
30	Jineshwar Malleable and Alloys	Karnataka
31	Jindal Steel and Power Ltd.	Chhattisgarh
32	Jeevaka Industries Ltd.	Telangana
33	Jayalakshmi Alloys India Pvt. Ltd.	Tamil Nadu
34	Jatin Ispat Pvt. Ltd.	Punjab
35	Jain Steels Pvt. Ltd.	Uttar Pradesh
36	Jai Raj Ispat Ltd – Telangana	Telangana
37	Jai Jagdamba Malleable Pvt. Ltd.	Uttar Pradesh
38	Jai Hind Wire Rod Mills	Tamil Nadu
39	Jagdamba Ispat	Rajasthan
40	Jagdambay Concast Pvt. Ltd.	Punjab
41	Jagat Metals Pvt. Ltd.	Punjab
42	Jagannath Steel Pvt. Ltd.	Uttar Pradesh
43	J T G Alloys Pvt. Ltd.	Punjab
44	J S Khalsa Steels Pvt. Ltd.	Punjab
45	J R Smelters Pvt. Ltd.	Tamil Nadu
	Re–rolling mills	
No.	Name	Address/location
01	Tapal Steel Pvt. Ltd. (Lakshmi Kalyani Ingots)	Karnataka
02	Concast Ispat Ltd.	West Bengal
03	Radha Smelters Ltd. - Shankarampet	Telangana
04	Southern Ferro Ltd. – Hubli	Karnataka
05	Dayal Steel Industries	Punjab
06	Bhagawathi Steel Industries	Chennai , Tamil Nadu
07	Shri Sugas Steels	Salem, Tamil Nadu
08	Madras Steel and Wire Products	Chennai , Tamil Nadu

09	Balaji Steels (Shri Ram Ispat Pvt.Ltd.)	Chennai , Tamil Nadu
10	Everest Industries	Tiruchirappalli, Tamil Nadu
11	Shri Alamell Steels	Salem, Tamil Nadu
12	Shree Lakshmiram Wires Pvt. Ltd.	Chennai , Tamil Nadu
13	Dhanlaxmi Iron Industries Ltd.	Medak, Telangana
14	Prime Gold International Pvt. Ltd.	Krishnagiri, Tamil Nadu
15	Nithya Steels and Alloys Pvt. Ltd.	Andhra Pradesh
16	Shyam Sel and Power Ltd.-Katwa	West Bengal
17	Sul Steel Pvt. Ltd.	Selest, West Bengal
18	V D S R Rolling Mills	Tiruvannamalai , Tamil Nadu
19	Shree Vela Smelters Pvt. Ltd.	Namakkal, Tamil Nadu
20	J B Steel Industries	Chennai , Tamil Nadu
21	Periyar Steels Pvt. Ltd.	Kerala
22	BEEKAY Steel industries Ltd.	Tamil Nadu
23	Kannappan Iron and Steel Co. Ltd.	Puducherry
24	Lasaum Steel Rolling Mills	Kerala
25	Hari Om Steel Industries	Jhansi, Uttar Pradesh
26	Rasik Industries	Punjab
27	H R Steel Rolling Mills	Punjab
28	Ganpati Steels PB	Punjab
29	Jupiter Enterprises	Rajasthan
30	Rama Sheets Pvt. Ltd.	Rajasthan
31	Mega Exim Pvt. Ltd.	Punjab
32	Sharu Steels Pvt. Ltd.	Punjab
33	B P Alloys Ltd.	Punjab
34	Shree Prathvi Steel Rolling Mill	Rajasthan
35	Arun Vyopar Udyog Ltd.	Tamil Nadu
36	Sardar Engineering Works	Telangana
37	Thangam Steels Ltd.	Tamil Nadu
38	V M T Steel Rolling Mills (P) Ltd.	Tamil Nadu
39	Popular Iron and Steel Co.	Uttar Pradesh
40	Minar Ispat Pvt. Ltd.	Kerala

41	Punathil Iron and Steels	Kerala
42	Rama Steel Re-Rolling Mill	Punjab
43	Shri Balaji Steel Rolling Mills	Punjab
44	Anand Steel Rolling Mills	Punjab
45	Bhoday Ispat Udyog	Punjab
46	Grihashakti Steels,	Guwahati, Assam
	Sponge iron plants	
No.	Name	Address/location
01	Orissa Cement Ltd.	Odisha
02	Scan Steels Ltd.	Odisha
03	Adhunik Corporation Ltd.	West Bengal
04	Shyam Sel	West Bengal
05	Monnet Ispat Ltd.	Chhattisgarh
06	Prakash industries Ltd.	Chhattisgarh
07	Nova Iron & Steel Ltd.	Chhattisgarh
08	Haldia Steel Ltd.	West Bengal
09	Beekay Steels & Power Ltd.	Orissa
10	Singhal Enterprises Pvt. Ltd.	Chhattisgarh
11	H E G Ltd.	Chhattisgarh
12	Sarda Energy & Minerals Ltd.	Chhattisgarh
13	Anjani Steels Pvt. Ltd.	Chhattisgarh
14	Bajrang Power & Ispat Ltd.	Chhattisgarh
15	Bhagwati Power & Steel Ltd.	Chhattisgarh
16	Agni Steel Pvt. Ltd.	Tamil Nadu
17	Nalwa Steel & Power Ltd.	Chhattisgarh
18	Bihar Sponge Iron Ltd.	Jharkhand
19	Tata Sponge Ltd.	Odisha
20	Shyam DRI Power Ltd.	Odisha
21	Sunflag Iron & Steel Co.Ltd.	Maharashtra
22	Ind. Synergy ltd.	Chhattisgarh
23	Orissa Sponge Iron & Steel Ltd.	Orissa
24	Shri Rangaraj Ispat (P) Ltd.	Tamil Nadu
25	Aarti Sponge And Power Ltd.	Chhattisgarh
26	Godawari Power & Ispat Ltd.	Raipur,
27	Hare Krishna Metallics Pvt. Ltd.	Panjim, (Goa)
28	Haryana Steel & Power	Bangalore
29	Hospet Ispat Private Limited	Koppal, Karnataka
30	Ganesh Sponge Pvt. Ltd.	Bhubaneswar
31	Gayatri Metals Pvt. Ltd.	Secunderabad

32	Electrotherm (India) Limited	Ahmedabad
33	Essar Steel Ltd.	Surat
34	Gallantt Metal Ltd.	Kolkata
35	Dinabandhu Steels & Power Ltd.	Odisha
36	Divyajyoti Steels Limited	Sandur, Karnataka
37	Chhattisgarh Sponge Iron Manufacturers Association	Raipur
38	Crackers India (Alloys) Ltd.	Keonjhar , Odisha
39	Dhanlaxmi Sponge Iron	Jalna, Maharashtra
40	Bellary Ispat Pvt. Ltd.	Bellary, Karnataka
41	BHUSHAN POWER AND STEEL LIMITED	New Delhi
42	Balajiswamy Premium Steels Pvt.Ltd.	Bellary, Karnataka
43	Baldev Alloys Pvt. Ltd.	Raipur (C.G.)
44	Anshul Steels Ltd.	Goa
45	Aryavrata Steel Pvt. Ltd.	West Bengal
R & D, design and service sector organisations		
No.	Name	Address/location
01	Mecon Limited	Jharkhand
02	R & D Centre For Iron & Steel	Jharkhand
03	National Metallurgical Laboratory	Jharkhand
04	CSIR- Institute of Minerals and Materials Technology	Odisha
05	Centre for Engineering & Technology	Jharkhand
06	Environment Management Division	West Bengal
07	Growth Division, SAIL	West Bengal
08	Kudremukh Iron Ore co. ltd	Karnataka
09	National Mineral Development Corporation Ltd.	Hyderabad
10	Dasturco Ltd.	West Bengal
11	National Mineral Development Corporation Ltd.	Hyderabad
12	Environment Management Division	West Bengal
Ferro-alloy plants		
No.	Name	Address/location
01	Rohit Ferro Tech Limited	Kolkata

02	Lalwani Industries Limited	Kolkata
03	Cosmic Ferro Alloys Limited	Kolkata
04	Maithan Alloys Limited	Kolkata
05	Tata Steel	Kolkata
06	Rashmi GROUP	Kolkata
07	VISA Steel	Kolkata
08	Mortex Group	Kolkata
09	V H P Group	Kolkata
10	Shyam Group	Kolkata
11	Amit Ferro-Alloys & Steel Pvt. Ltd.	Kolkata
12	Abhijeet Group	Kolkata
13	S R C Group	Kolkata
14	Indian Metals and Ferro Alloys Ltd.	Odisha
15	Jai Balaji Group	Kolkata
16	Ferro Alloys Corporation Ltd.	Kolkata
17	Balasore Alloys Ltd.	Kolkata
	Refractory industries	
No.	Name	Address/location
01	TRL Krosaki Refractories Limited	Kolkata
02	Calderys India Refractories Limited	Nagpur
03	Maithan Ceramic Ltd.	Dhanbad
04	OCL India LTD.	Odisha
05	IFGL Refractories Ltd.	Kolkata
06	Sarvesh Refractories Limited	Odisha
07	Premier Refractories of India Pvt. Ltd.	M.P
08	Carborundum Universal Ltd.	Chennai
09	Orient Refractories Limited	Bhiwadi, Rajasthan
	Merchant pig iron industries	
No.	Name	Address/location
01	Aparant Iron & Steel Ltd.	Panaji, Goa
02	Electro Steel Castings Ltd.	Kolkata
03	IDCOL Kalinga Iron Works Ltd.	Keonjhar, Orissa
04	Jindal Saw Mills Ltd.	New Delhi
05	Kirloskar Ferrous Industries Ltd.	New Delhi
06	Kudremukh Iron Ore Company Ltd.	Bangalore

07	Lanco Industries ltd.	Chennai
08	Sathavahana Ispat Ltd.	Hyderabad
09	Southern Iron & Steel Co. Ltd.	Tamil Nadu
10	Tata Metaliks Ltd	Kolkata
11	Concast Ispat Ltd	Kolkata Srikakulam (A.P.)
12	Sesa Industries Ltd Ltd	Panjim, Goa
13	KIC Metaliks Ltd	West Bengal
14	Malavika Steel Ltd	Jagdishpur, Sultanpur (U.P.)
15	Neelanchal Ispat Nigam Ltd	Odisha
16	Mesco Steel Ltd	Odisha
17	Visa Industries Ltd	Kolkata, India
18	Sona Alloys Pvt Ltd	Maharashtra
19	Neo Metaliks Ltd	Kolkata
20	Rashmi Group	Kolkata
21	SBQ Steels Ltd	Chennai
22	Kalyani Gerrdau Steels Ltd	Bangalore
23	VSL Steels Limited	Bangalore

APPENDIX IV

Engineers (Graduate and Diploma holders) and ITI certificate holders per thousand tonne of product as well as discipline wise engineers per thousand tonnes of product deduced from the survey results

(i) Characteristic distribution of technical manpower engaged in production in the steel and relevant allied sectors

Sectors	Total production, thousand tonne	Total technical manpower in production	Graduate engineers per thousand tonne	Diploma engineers per thousand tonne	ITI certificate holders per thousand tonne
Integrated Steel Plant	53047	64924	0.3609	0.3363	0.5267
Alloy Steel Plants	7436	9561	0.3582	0.3515	0.5762
Induction Furnace	893	661	0.2217	0.2172	0.3023
Sponge Iron Plants	992	209	0.0252	0.0796	0.1068
Re-Rolling Mills	4602	1391	0.0834	0.0719	0.1471
Refractory Industries	409	323	0.1955	0.3863	0.2102
Ferro Alloy Plants	279	159	0.0537	0.1111	0.4086
Merchant Pig Iron	1288	569	0.2181	0.1141	0.1102
Mineral Beneficiation & Pelletizing	8300	257	0.01168	0.0127	0.0066

(ii) Characteristics of discipline-wise graduate engineers' distribution in the steel and relevant allied sectors

Sectors	Total Production, '000 Tonne	Total graduate engineers in Production	Graduate Engineers per thousand tonne						
			Met. Engg.	Mech. Engg.	Elec. Engg.	Chem. Engg.	Cera-mic Engg.	IT & CSE	Others
Integrated Steel Plant	53047	19144	0.0587	0.1411	0.0762	0.0179	0.0034	0.00997	0.0533
Alloy Steel Plants	7436	2660	0.0446	0.1867	0.0923	0.0051	0.0009	0.0038	0.0244
Induction Furnace	893	197	0.0055	0.1276	0.0358	0.0100	00	00	0.0425
Sponge Iron Plants	992	24	0.0070	0.0100	0.0060	00	00	00	0.0020
Re-Rolling Mills	4602	388	0.0010	0.0619	0.0202	0.0006	00	0.0008	00
Refractory Industries	409	79	0.0073	0.0537	0.0122	0.0342	0.0488	00	0.0391
Ferro Alloy Plants	279	14	0.0071	0.0250	0.0215	00	00	00	00
Merchant Pig Iron	1288	275	0.0100	0.1079	0.0745	0.0155	00	0.0054	0.0007
Mineral Beneficiation & Pelletizing	8300	102	0.0010	0.0068	0.0030	00	00	00	0.0016

(iii) Characteristics of discipline-wise diploma engineers' distribution in the steel and relevant allied sectors

Sector	Total Production, '000 tonne	Total diploma engineers in production	Discipline-wise diploma engineers per thousand tonne						
			Met. Engg.	Mech. Engg.	Elect. Engg.	Chem. Engg.	Ceramic Engg.	IT & CSE	Others
Integrated Steel Plant	53047	17923	0.0398	0.1532	0.0846	0.0059	~0.002	0.0038	0.0493
Alloy Steel Plants	7436	2623	0.0258	0.2017	0.0855	0.0008	~0.0001	0.00134	0.0375
Induction Furnace	893	193	0.0100	0.1063	0.0369	0.0022	00	0.0022	0.0593
Sponge Iron Plants	992	78	0.0060	0.0483	0.0221	00	00	0.0030	00
Re-Rolling Mills	4602	329	0.0010	0.0441	0.0193	0.0010	00	0.0008	0.0054
Refractory Industries	409	157	0.0024	0.1931	0.0317	0.0122	0.090	00	0.0562
Ferro Alloy Plants	279	30	0.0107	0.0609	0.0358	00	00	00	0.0035
Merchant Pig Iron	1288	146	0.0131	0.0566	0.0310	0.0031	00	0.003	0.0069
Mineral Beneficiation & Pelletizing	8300	104	00	0.0081	0.0032	00	~0	00	0.0012

APPENDIX V

List of attendees and their affiliation in the workshop held at IIT Kanpur on the 13th of April 2015.

Serial number	Member	Affiliation
1	Dr.Indranil Manna	IIT Kanpur
2	Dr. Dipak Mazumdar	IIT Kanpur
3	Dr.Amarendra Singh	IIT Kanpur
4	Dr.T Venugopal	Tata Steel, Jamshedpur
5	Dr.Vinay K.Gupta	Formerly with RDCIS, SAIL
6	Dr. Arup Ghosh	CGCRI, Kolkata
7	Mr.R.K.Bagchi	NISST, Govindgarh
8	Mr. Sushim Banerjee	INSDAG, Kolkata
9	Mr.Shaktimoy Ghosh	Formerly with JSPL, Raigarh
10	Mr.Bhaskar Roy	Formerly with IIM Kolkata
11	Dr. PJ Rochowdhury	Formerly , Professor BE College
12	Dr. Tridibesh Mukherjee	Former IIM President
13	Shri P.L.Satish	Hospet Steels, Karnataka
14	Mr. Siddhartha Shah	HR, Tata Steel Jamshedpur
15	Dr. B.B.Agarwal	RDCIS, SAIL, Ranchi
16	Prof. G.Gupta	IISc., Bangalore
17	Mr. Nitin Amte	Essar Steel, Hazira
18	Mr. Kamal Aggarwal	AIIFA, New Delhi
19	Dr. Marutiram Kaza	JSW, Bellary
20	Sadhan K. Roy	IIM Kolkata
21	SK Bhatnagar	Ministry of Steel, New Delhi
22	Dr. Soumitra Tarafdar	NML, Jamshedpur
23	Mr. V.Srinivas	RINL, Vishakhapatnam
24	Shri Amarendu Prakash,	SAIL, Bokaro
25	Shri Manish Jalota,	DAIL, Bokaro
26	Dr. M.Venkatraman	Essar Steel, Hazira
27	Prof. R.Shekhar	IIT Kanpur
28	Prof. K Biswas	IIT Kanpur