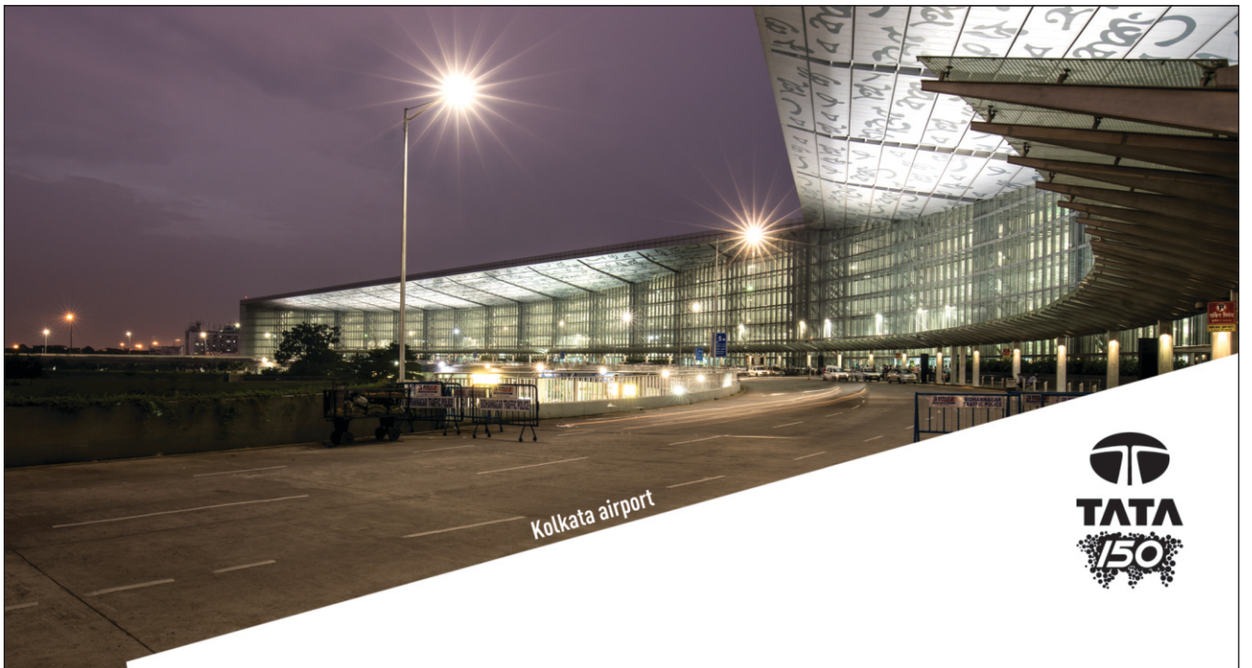
IIM METAL NEWS

ISSN 0972-0480 Monthly VOL. 22. NO.1 JANUARY 2019

IIM Metallurgy Materials Engineering

The Indian Institute of Metals



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Printed by Shri Kushal Saha at COSMIC, 127, Baithakkana Road, Kolkata – 700009, Phone : (M) 9433630433, 9836772503(O) 03323510705
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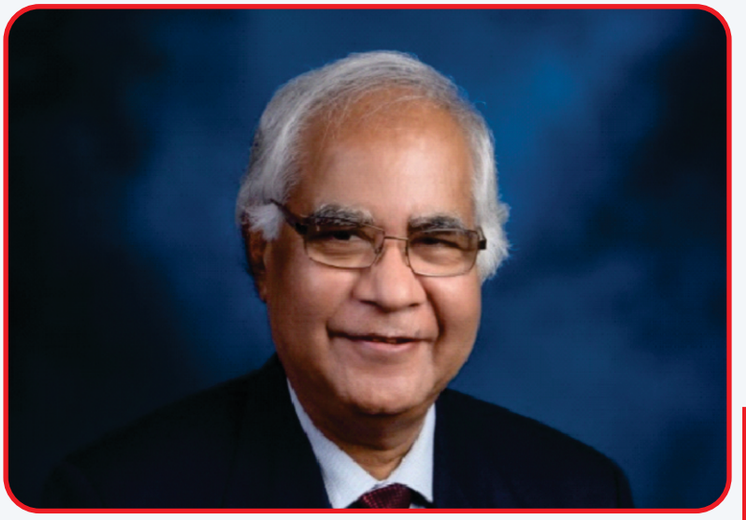


BALDEV RAJ

9/4/1947 - 6/1/2018

The saddest moment is when the person who gave us the best memories, becomes a memory…….

Remembering you is easy, but missing you is heartache , that never goes……..

Season's Greetings and Best wishes
for
a peaceful, proficient and prosperous New Year
(2019)

Sustainable development and Safety in the steel industry

A sustainable circular economy is one in which society reduces the burden on nature by ensuring resources remain in use for as long as possible. Once the maximum value has been extracted, the resources are then recovered and reused, remanufactured, or recycled to create new products. Society's needs for things such as food, housing, transportation and energy, can be met without the production of waste. Steel is fundamental to the circular economy. Not only can steel products be reused and remanufactured, steel is also a permanent material which can be recycled over and over again without losing its properties. The industry is continuing to expand its offer of advanced steel products for many different sectors, such as high-strength steels which reduce the weight of applications, and encourage circular economy practices. For society, the benefits include more efficient and durable products, reduced emissions, and the conservation of raw materials for future generations – a more sustainable future. In addition, the steel industry is also making a concerted effort to ensure the safety and health of its employees and to engage with local communities where steel is produced. The industry also provides education and training opportunities that will foster the innovation needed for a circular economy, through company-specific and industry-led initiatives. The sustainability report focuses on three aspects: steel as a critical enabler and partner for other industries in a sustainable society; steel as an industry which takes its commitments and responsibilities seriously; and the challenges facing the industry along with initiatives that are in place to address them.

The steel industry recognised the need for a systematic method to measure and report on its sustainability performance. To this end, world steel established a set of sustainability indicators in 2003. The indicators are aligned to the principles in world steel's sustainable development policy and to the UN Sustainable Development Goals. Sustainability reporting at a global level is one of the major efforts that the steel industry undertakes to manage its performance, demonstrate its commitment to sustainability and enhance transparency. It is one of the few industries that reports at a global level and has done so since 2004, when the first steel industry sustainability report was published. Steel companies report on up to 8 sustainability indicators every year

ENVIRONMENTAL PERFORMANCE: Greenhouse gas emissions, Energy intensity, Material efficiency Environmental management systems

SOCIAL PERFORMANCE: Lost time injury frequency rate, Employee training

ECONOMIC PERFORMANCE: Investment in new processes and products, Economic value distributed

Reporting is voluntary. In 2017, 125 steel companies and 6 associations participated. Crude steel, produced by companies who reported on one or more indicators for fiscal year 2016 was 875 Mt, representing 54% of global crude steel production.

SAFETY

Historically, steelmaking was a dangerous process and accidents were inevitable. Today, many steel companies recognise that this is no longer appropriate for a modern and technically advanced industry.

There is no area, process or type of work that cannot be accident-free. Safety and health requires a permanent 100% commitment from everyone. Most importantly, it requires a strong commitment from top management and all levels of management, which should set the culture in which safety and health is the number one priority and must not be compromised for any other objective.

Steel companies are improving their safety and health performance and some businesses have gone without any lost time injuries or fatalities for many years. These companies know that such performance requires excellence in all aspects of their operations. This excellence also produces superior business performance - the most successful steel companies are also the safest.

Six safety and health principles for the industry:

1. All injuries and work-related illness can and must be prevented.
2. Management is responsible and accountable for safety and health performance.
3. Employee engagement and training is essential.
4. Working safely is a condition of employment.
5. Excellence in safety and health supports excellent business results.
6. Safety and health must be integrated in all business-management processes.

https://www.worldsteel.org

PROFESSOR NP GANDHI MEMORIAL LECTURE

Reflections of an Indian Metallurgist

Sanak Mishra
Senior Advisor, MIDHANI & Formerly : MD, Rourkela Steel Plant and Director of SAIL Board;
CEO, Arcelor Mittal India Limited; President, Indian Institute of Metals

First of all, I am much thankful to the Indian Institute of Metals (IIM) for selecting me for delivering the Professor NP Gandhi Memorial Lecture. I am overwhelmed by the knowledge that before me, many outstanding and eminent educationists and scientists have addressed the IIM community commemorating the exceptional dedication and leadership of the Late Mr. NP Gandhi.

My lecture will be in three parts. The first part will comprise a few words about the genius of Prof. Gandhi, and some personal remarks about my contacts with BHU Metallurgy Department. Bearing in mind Prof. Gandhi's quest for knowledge, I shall in the second part outline some ideas I have developed on the meaning of knowledge and the basic model of the individual as a powerhouse. In the third part I shall present a macroscopic view of some pertinent features of the Indian Steel scenario with which I have been connected quite intimately; in fact I feel very proud that in my professional career path I have not only witnessed but also participated and contributed to the transformation and phenomenal growth of Indian Steel from less than 10 million tons to a giant of over 100 million tons, poised for even further growth in the coming years.

Nagardas Purushotham Gandhi, born 1886, graduated from the Wilson College, Bombay and obtained his A.R.S.M. degree in 1911 from the Royal School of Mines, Imperial College of Science and Technology, London; in both the cases, he topped the class. He began his professional career with the Copper Works, Japan and subsequently served for three years as the General Manager of the Tata Sons Ltd at Tovoy, Burma. In 1919 he was recommended by Mahatma Gandhi to Pandit Madan Mohan Malaviya, founder of the Banaras Hindu University (BHU), to help the latter in organizing the engineering branches of study at the Banaras Hindu University. Thanks to his dedicated efforts, a composite Department of Geology, Mining and Metallurgy was started in the year 1923 and the first-ever bachelor's degree course in Metallurgy was thus established in India. Professor Gandhi retired from BHU in 1942, but continued to take active interest in the metallurgical profession till his demise in 1960. His impact on metallurgical education was of a pioneering nature and can be felt even today. I came to learn about this iconic personality as an undergraduate student of Metallurgy at the Indian Institute of Science where a few of our teachers had studied at BHU. I was influenced to a large extent by his yeomen service to the cause of metallurgical education in India.

In 1973, I was at the University of Illinois at Urban-Champaign, USA where I had obtained my MS and PhD degrees in Metallurgical Engineering while being a Research Assistant with Prof. Paul A. Beck. From here, I was directly recruited as a Founder Member of the Research & Development Centre of the Steel Authority of India Limited at Ranchi, now known as RDCIS. I had the occasion to meet Prof. Anantharaman, the Head of the Department of Metallurgy some time in 1978. He was aware of my work with Prof. Beck on magnetic susceptibility measurements from room temperature down to below liquid helium temperatures which had led to the discovery of magnetic clusters in dilute alloy systems and he invited me to BHU. As a follow up, in 1979 I spent a few days there as a UGC Visiting Fellow, taking a short leave from RDCIS. Apart from interactions with Prof. Anantharaman, I had consultations with Prof. Malhotra, Prof. Rama Rao, Prof. Ranganathan, Prof. Suraj Bhan and Prof. Padmanabhan. Discussions focussed on my just published extensive review of the determination of atomic order - disorder information from magnetic data. I also delivered a guest lecture on Electrical Steels used in motors, generators and transformers. A couple of years later, in 1981, when I was Alexander von Humboldt Fellow in Germany at the Aachen Technical University, I had gone to Baden to participate in the Annual meeting of the German Metallurgical Society (DGM) and make a presentation on the development of the cube-on-edge Goss texture in silicon steels. My work with Prof. Kurt Luecke, applying for the first time, to the fullest extent, the newly developed Orientation Distribution Function Analysis Technique to body centred cubic metals, had led to the discovery of the texture memory effect and we had proposed a texture inheritance model to explain that. As it turned out Prof. Ananatharaman, who had an active association with German academicians, was also at the same conference and was happy to learn about my work. He very kindly suggested that on my return to India I should take up the position of a full Professor at BHU. Indeed in1982, a few months after I had come back, I received a telegram and a letter from Prof. Suraj Bhan, who was the then Department Head, asking me to come for an interview for the post of Professor of Physical Metallurgy. At this point I was in my mid-30's and the prospect of being a Full Professor at a prestigious university at such an age was very tempting. However, I was already committed to building up the RDCIS as a premier organization of world repute. I, therefore, humbly excused myself, although in many ways BHU would have been an ideal place to pursue not only my scientific curiosity but also my fascination with the subject of the evolution of "knowledge" in vedic and post-vedic periods in ancient India, and my studentship of the development of musical traditions. As a matter of fact, as a young boy of nine I was encouraged by my polymath father to train as a musician. Little did I know then that, instead, I would end up as a metallurgist! Some of you might recollect that the title of my Address as IIM President in NMD 2009 was "Of Metals, Music and the Metallurgist". Over the years I have kept in touch with BHU faculty, collaborated with them, and visited the campus on several occasions.

I shall now move on to the second part and the third (last) part of my lecture, using slides.

Prof. N.P. Gandhi Memorial Lecture

Reflections of an Indian Metallurgist

Dr. Sanak Mishra

Presently
Senior Advisor, MIDHANI

Formerly
Managing Director, Rourkela Steel Plant and Director, SAIL
Vice President of ArcelorMittal and CEO India Projects
Secretary General, Indian Steel Association
President, Indian Institute of Metals
Chairperson, IOMMMS*
*(*International Organisation of Materials, Metals and Minerals Societies)*

The Hierarchy of Knowledge

Epistemology and Kant

- **Epistemology** is the philosophy of knowledge. It seeks to answer fundamental questions such as : What is knowledge, or the meaning of knowledge? What kind of knowledge there is? Is it possible to have knowledge? How people acquire knowledge?
- **Immanuel Kant**, the German philosopher argued in his major work "Critique of Pure Reason" (*Kritik der reinen Vernunft*, 1781), that the human mind creates the structure of one's experience, i.e., *that our experiences are structured by necessary features of our minds.*

Kant did not, however, subscribe to the idea of empiricists that all knowledge comes from experience alone.

The Meaning of Knowledge

Basic Reference Frame

- Buddhi (Intelligence, Intellect)
- Vidya (Scholarship)
- Gnana (Knowledge)

What is "PRAGNA"?

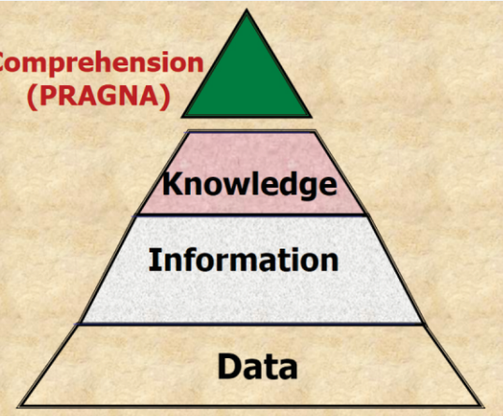
The word "Pragna" appears in the Vedic literature. In a nutshell, it refers to a composite of the highest and transcendental form of wisdom, intelligence, awareness and understanding.

Pragna is described as that state of wisdom which is higher than the knowledge obtained by reasoning and inference.

***A Simplistic, yet Holistic Classification of Knowledge** (mishra)*

Spiritual
Scientific
Relational
Carnal*

**Ref: Ubhaya Bharati* (wife of Mandana Misra of Bihar; an advocate of Karma Mimamsa school of orthodox Hindu philosophy), who won a round of debate with Shankaracharya



The Hierarchy of Knowledge (mishra)

Whereas **data** is likely to be located in private domain, and **information** generally lies in public domain, **knowledge** is primarily with the individual, although it may also reside at other places, e.g., an institution, a workplace, a bibliothek .

On the other hand comprehension is principally with the individual. It is something higher than knowledge; the other distinction is that comprehension is something that the institutions do not possess. It is right there in one's head.

Dream, or, Comprehension?

- *In 1865, Friedrich August Kekule published a paper (Bulletin de la Societe Chimique de Paris; 3, 98–110) suggesting that the structure of the Benzene molecule contained a ring of six carbon atoms with alternating single and double bonds, and a hydrogen atom attached to each carbon atom. In 1890 Kekulé said that he had discovered the ring shape of the benzene molecule after a day-dream of a snake siezing its own tail.*
- *Elias Howe, the American inventor of the modern sewing machine needle with the eye at the tip (Lockstitch Method Sewing Machine U.S. Patent #4750, issued 10 September 1846) claimed that in a dream he had, he was being chased and attacked by cannibals with spears that had holes in their tips. It was after this dream that he realized that the sewing needle in his invention must have a hole in the tip to put the thread through it.*

How does one describe Comprehension?

An appropriate description of comprehension would be that it represents the ability to grasp, to perceive and to concieve, and to generalise, and this ability is only found with the individual. It can never come to an institution.

PS: The term Comprehension, as used here, has some similarity with, but is not identical to Michael Polyani's 1950's hypothesis of "Personal Knowledge", or "Tacit Knowledge". Personal Knowledge: Towards a post-Critical Philosophy; University of Chicago Press. ISBN 0-226-6728833; 1958. Polanyi advocates that all knowledge claims (including those that derive from rules) rely on personal judgements.

(Polanyi is well known to metallurgists, as one of the three inventors in 1934 of what we now know as dislocations, the other two being Egon Orowan and Geoffrey Taylor.)

OUR VERY OWN LEGENDS

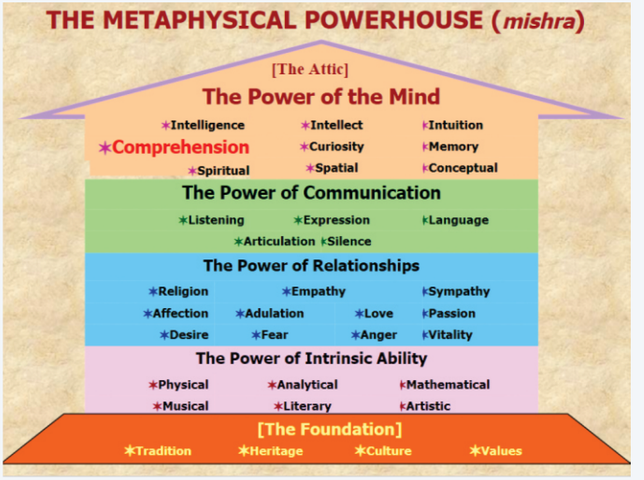
- ***Arjuna's Comprehension of the Universe***:Krishna reveals his cosmic form to Arjuna - Bhagvad Gita, Chapter 11. *(This is the chapter which Robert Oppenheimer quoted when he said that creating the atomic bomb made him feel like a "destroyer of worlds". Oppenheimer's Comprehension?)*
- ***Siddhartha Gautama' s Comprehension of the "Four Noble Truths".*** Seated under a Pipal tree, later named the Bodhi Tree, after 49 days of meditation at the age of 35, attained Enlightenment and became known as the *Buddha,* or the "Awakened One". *(According to some sutras of the Pali canon, at the time of his awakening he realised complete insight into the "Four Noble Truths".)*

Some Interesting Questions that remain

- **Will Knowledge, per se, lead to Comprehension?**
- **Does Comprehension necessarily depend on "Prior Knowledge", or it can arise without any link to knowledge garnered earlier?**
- **Can Comprehension be instantaneous with a single observation, or is it the sum total learning from many observations?*****
- **Is the abilty to comprehend a faculty of the mind, like intelligence?**

****What triggered Newton to hit upon the idea that two masses (bodies) will attract each other? (Newton's Universal Law of Gravitation; Philosophiæ Naturalis Principia Mathematica, July 1687; explains why the apple fell from the tree.)*

(mishra)



Metaphysics, Mind and Matter

Metaphysics, derived from Greek words, is the branch of philosophy that studies the questions of "being" and "reality".

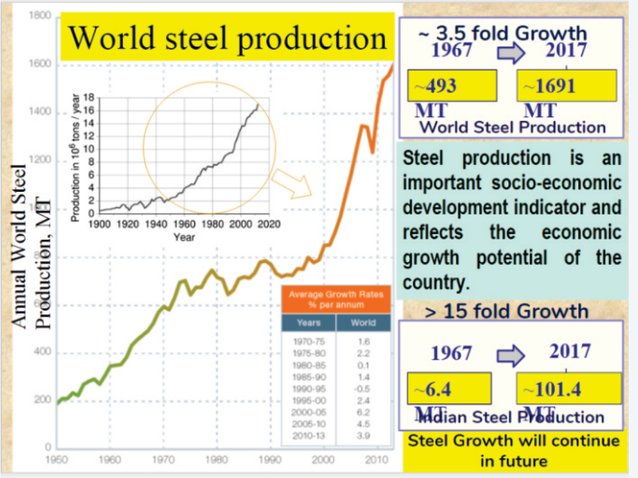
Accounting for the existence of mind in a world otherwise composed of matter is a metaphysical problem.

The Transformation of Indian Steel

The Power of the Mind is the Supreme Power of the Individual

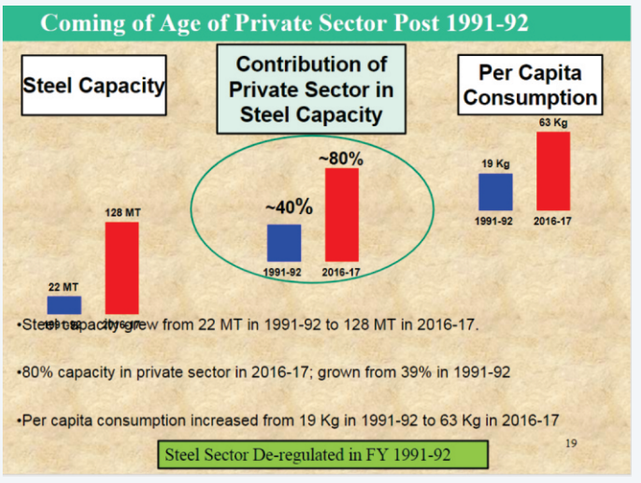
The expanse of the Mind is infinitely larger than the expanse of the expanding Universe

(mishra)



Hypothesis of the Distance Between Minds(mishra)

Common Purpose and Engagement and Mutual Trust hold the Key to reducing the distance between minds.

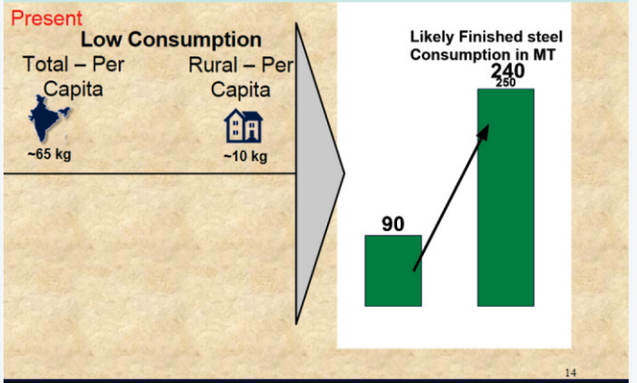


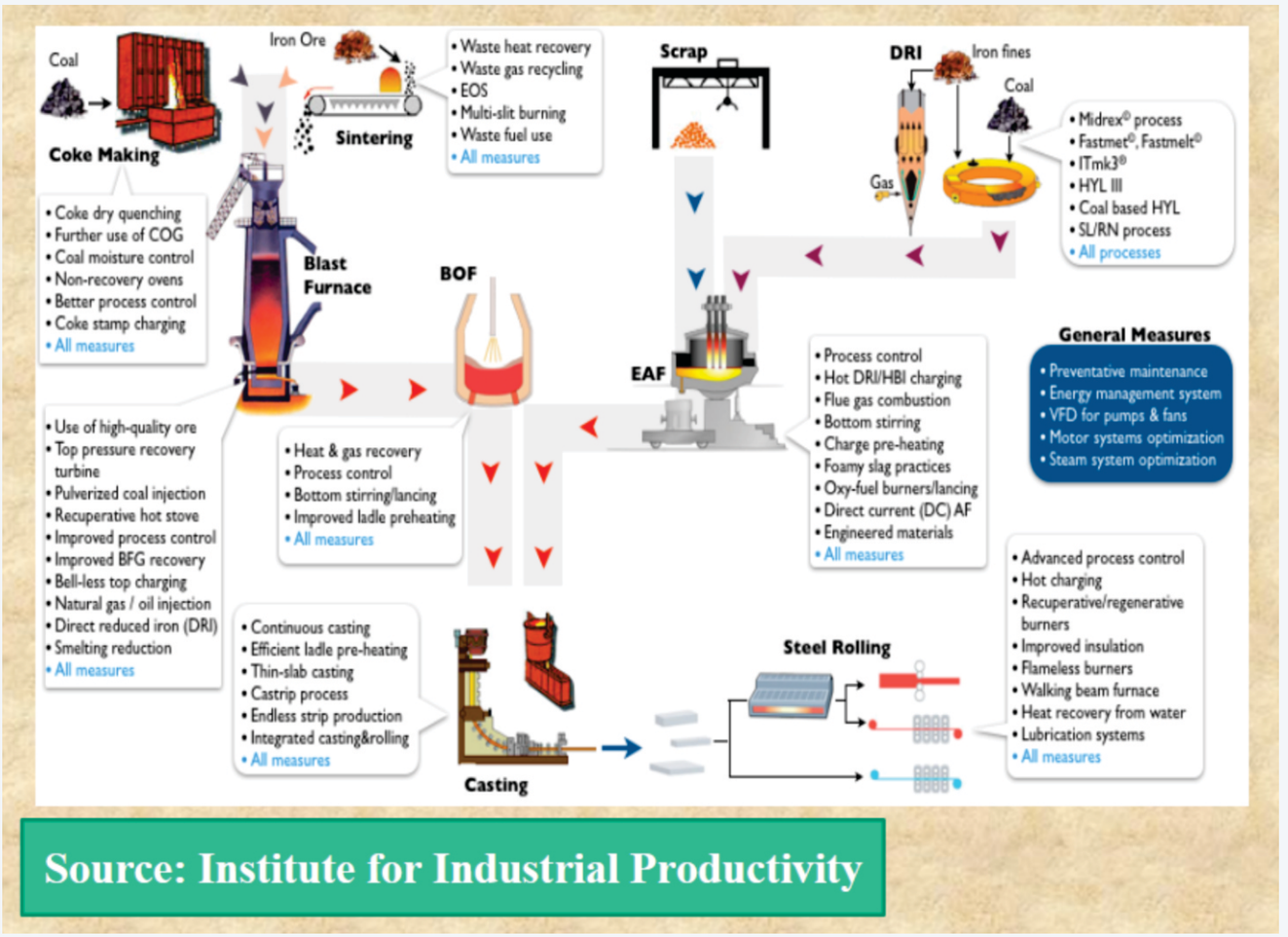
National Steel Policy 2017

- The Cabinet, in May 2017, approved the National Steel Policy 2017 that envisages Rs. 10 lakh crore investment to take capacity to 300 million tonnes by 2030-31, to give a boost to the domestic steel sector.
- To boost domestic steel consumption, the government in May 2017 also approved a policy providing preference to domestic iron and steel products in government procurement.

Source-National Steel Policy-2017,Ministry of Steel, MT-Million Tons

Steel Consumption projected to grow to 240 MT by 2030-31





Source: Institute for Industrial Productivity

Fundamentals of Steel Industry in India having a bearing on Competitiveness

- **Strengths**
  - Availability of iron ore and thermal coal deposits
  - Low labour wage rates, compared to industrialised nations
  - Availability of college educated manpower
  - Mature production base
- **Weaknesses**
  - High Energy Consumption
  - High Carbon Dioxde Load
  - Coking coal import dependence
  - Low R&D investments
  - High cost of debt
  - Inadequate infrastructure
  - Inadequate Logistics
- **Opportunities**
  - Unexplored rural market
  - Growing domestic demand
  - Exports Potential ?
  - Possible Consolidation
- **Threats**
  - China becoming net exporter
  - Protectionism in the West
  - Dumping by competitors
  - Increase in prices of raw material especially coking coal

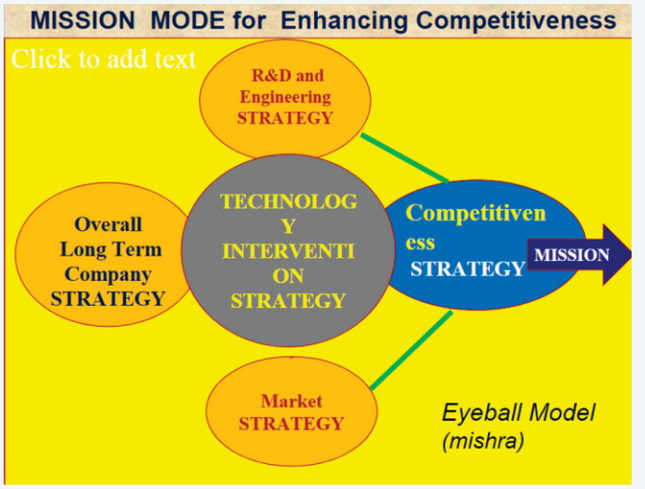
Steel Research & Technology Mission of India (SRTMI)

Ministry of Steel has taken full cognizance of the technological scenario in Indian Steel Industry and has initiated a fresh move for promotion of R&D in Iron & Steel Sector in India.

To bring in all the stake-holders into one platform and promote steel research on themes of critical and vital national importance, an institutional platform called,

"Steel Research and Technology Mission of India"

has been established with an objective to spearhead R&D of national importance in iron & steel, creating state-of-art facilities to conduct cutting-edge research, develop expertise & skill, manage human resources and bolster a tripartite synergy amongst industry, national R&D laboratories and academic institutes



ACKNOWLEDGEMENTS

I owe much to my wife Veena, for her continual support in my never-ending journey through the wonderland of metallurgy and materials science.

Dr. DAYA SWARUP MEMORIAL LECTURE

Materials/ Metallurgical Engineering Undergraduate Curriculum: Challenges and Opportunities

Surya Pratap Mehrotra
Visiting Professor, IIT Gandhinagar &
Formerly: Director, NML (CSIR), Jamshedpur; Professor, Materials & Metallurgical Engineering Department, IIT Kanpur

I feel highly privileged and greatly honoured for being selected for delivering Prof. Daya Swarup Memorial lecture'2018. I wish to take this opportunity to express my sincere thanks to the IIM Council, the Award Committee and the BHU Trust for inviting me for this lecture. Prof. Daya Swarup, the doyen of Metallurgical Education in India, has been a source of inspiration not only for people like me who have been directly associated with academia but also for a very large number of very distinguished alumni of BHU who had the privilege of being taught metallurgy by him. His books on metallurgy motivated and inspired metallurgists of that era all over India. His contributions to metallurgical education in India have been seminal.

While I was debating in my mind for an appropriate topic for this particular lecture, my initial temptation was to present an overview of one of my own areas of research. But then it occurred to me that for this occasion I should pick up a topic which would have been of interest to Prof. Daya Swarup had he been alive today. I felt my best tribute to this 'Doyen of Metallurgical Education in India' would be to talk about present status of Metallurgical/ Materials Engineering Education in our country and the direction in which it is likely to move in the next decade or two. Hence, this particular topic for this lecture.

CHANGES IN ENGINEERING EDUCATION PARADIGM

Engineering Education all over the world is undergoing major paradigm shift because of the following factors:

1. The pace at which technological changes are taking place today is phenomenal. Even the state-of-the art technologies adopted by most modern plants today are likely to become routine or even obsolete in five to ten years from now. Thus, if the engineering education tries to prepare the engineers based on today's needs of industry, the budding engineers graduating four to five years from now have a real danger of being obsolete by the time they graduate
2. The aspirations and expectations of the present generation of students are very different from those of 2- 3 decades ago. The bright young students when join the institutes for engineering education are not really sure what kind of career will they ultimately go for – the first engineering degree may just be a stepping stone for a very different career in the future, not necessarily linked with engineering discipline at all. The students therefore are often keen to develop a wide knowledge base encompassing several disciplines
3. The World Federation of Engineering Organization (WFEO) standing committee on education in engineering is demanding that engineering education at all levels and in all disciplines should be oriented towards sustainable development fostering environmentally-aware attitude, skills and behavior patterns, as well as a sense of ethical responsibility[1,2]. This requires adding several new kinds of courses to the Engineering curriculum.

As stated by Hannah and Hayes [3], "the existing engineering paradigm is one of determinism where each and every problem in engineering can be broken into a series of sub-problems for which a unique deterministic solution exists. There is, however, now a realization that this paradigm has limitations and is not really valid in many multidimensional complex engineering problems where there is significant interaction between the sub-components. While the present determinism approach may remain valid for several well defined problems, it needs to be substantially modified by embracing the concepts of complexity." This requires developing new engineering approaches and methodologies to find solutions to problems with large interactive components. Closely associated with the large interactive problems is the issue of Risk Management which requires a totally different kind of expertise, not generally covered and introduced in the undergraduate engineering curriculum, but needs to be included as a part of the curriculum sooner than later.

Professional Engineering Societies in the Developed World have recognized that a narrow technical focus is no longer valid. Real life problems are not bound to a particular discipline – they require multi-disciplinary approach for a realistic and meaningful solution. Therefore, beside one's own discipline, many other attributes and competencies are equally important to know the wider world and to work interactively within this world. Several of these skills will have to be developed through the courses as the part of the undergraduate curriculum.

Engineering Education for Sustainable Development

In the words of Brundtland report [4], 'we must learn to care for the present without compromising the ability of future generations everywhere to meet their own needs'. Man's greed and exploitation of the biosphere is threatening its very existence and delicate balance. Over the last few decades the pressure on global environment has become self-evident, leading to a common outcry for sustainable development. To ensure that professional engineers are conscious of this fact and they follow practices which are needed for sustainable development, it is necessary to make them aware of these realities and prepare them to deal with these during their undergraduate education itself by introducing relevant courses in the curriculum. It is suggested that the engineering students should be trained to [2]

- Recognize the problems of our society
- Assess the contribution that technology might offer in solving these problems
- Assess the limitations of technological solutions
- Acquire basic knowledge of social science
- Study interdisciplinary projects in cooperation with students of social sciences and humanities

This requires a new teaching approach oriented towards sustainable development. Development of new basic courses integrating into disciplines, development of new disciplines and specialization in new system approaches need to become essential part of the curriculum.

PRESENT STATUS OF METALLURGICAL/ MATERIALS ENGINEERING EDUCATION IN INDIA

There are over 10000 AICTE approved engineering colleges/ institutions in the country today but the number of institutions providing quality engineering education is perhaps not even 500. In the academic year 2016-17, the total number of available seats in these institutions combined together was over 15 lacs. The total enrolment, however, during this academic year was just around 50 %. Although 7 to 8 lacs engineering students are being awarded degrees every year for past several years, not more than 20-25% of these are employable for engineering jobs. Since the demand for graduate engineers is more than this number, the industry, R&D and academia all are facing problem in finding suitable candidates for their various positions.

The scenario for Metallurgical/ Materials engineers is even worse because the total number of graduating Metallurgical/ Materials engineers is much smaller. There are only about 55-60 engineering institutions which are awarding undergraduate degrees in Metallurgical/Materials Engineering or Materials Science and Engineering. The list of Institutions awarding degrees in Metallurgical/Materials Engineering including Materials Science and Engineering is given in Annexure 1. The total number of available enrolments in these institutions is less than 3000, but the number of actual admissions each year is only about 2000 – 2500, as Metallurgical/ Materials Engineering is no longer a popular discipline amongst the students. Hence many seats remain vacant at the time of admission itself; some more get vacated after first year because of liberal branch change rules in many institutions. Thus, the number of students graduating with Metallurgy/ Materials degree yearly may not exceed 2000. How many of these are truly employable for Metallurgy/ Materials related jobs is a debatable issue. One thing for sure is that all three sectors, e.g. industry, academia and R&D pertaining to metallurgy/ materials are clamouring for quality Metallurgical/ Materials graduates.

CHRONOLOGY OF CHANGES IN DEPARTMENTS NAME AND METALLURGICAL ENGINEERING CURRICULUM

Changes Around Early to Mid-Nineties

Around early nineties, starting with IIT Kanpur and IIT Bombay, many Metallurgical Engineering departments in the country changed their name to Materials and Metallurgical Engineering or Metallurgical Engineering and Materials Engineering. This was essentially done to make the discipline more attractive and glamorous to the students who were slowly losing interest in metallurgy as a discipline. An impression was created among the students that metallurgy courses were of routine type descriptive courses and did not offer enough intellectual challenge. Though not necessarily true, several departments tried to counter this impression by adding several new courses pertaining to new and advanced materials and their processing by phasing out some of the descriptive, routine industrial processes specific courses. Since most institutions did not allow the departments to increase the total contact hours beyond what were already existing, addition of new courses was possible only by replacing some of the existing courses. As a result, during revision of the curriculums in nineties in many Metallurgical Engineering departments courses related to mineral processing, process metallurgy (in particular extractive metallurgy), forming processes were replaced by courses in Advanced Powder Metallurgy, Advanced Ceramics, Instrumentation and Control, etc. Further, the fairly rigid curriculum of eighties and early nineties that existed and which hardly had any scope for elective courses to be chosen by the students, started opening up a bit to provide a few elective slots (1-2) to allow students to take courses of their choice. This too needed some additional slots to accommodate these elective courses.

Changes Around 2005 Onward

Around mid-nineties to the beginning of the new millennia was the time when many Metallurgical Engineering departments in North America and Europe were undergoing major transformations. As the process industry started moving out from these countries to the third world countries because of high labour costs and concerns for environment pollution, the funding for research in conventional areas of metallurgy became more and more difficult to come by. This forced the young and very bright metallurgy faculty to drift towards the research areas in which funding was easily available. This led to first the academic research and then the academic curricula to quickly drift towards Materials Science. As a result, several renowned and established Metallurgical Engineering departments in most universities in U.S. as well as Europe became departments of Materials Science and Engineering and/ or were merged with other departments like Chemical, Mechanical Engineering, Applied Chemistry, etc. Consequently, academic activities in the areas related to process metallurgy (extractive metallurgy) were greatly curtailed.

The changes that took place in North America and Europe had their impact on Indian academia as well. Many funding agencies in India also adopted several new areas like Super Conductivity, Nano Materials and Nano Technologies, Thin Film Technologies, Bio-materials as the emerging technologies started funding generously. Consequently, funding for conventional research areas related to disciplines like Mineral Processing, Process Metallurgy, etc. became scarce, forcing the faculty to take up those research areas in which there was greater possibility of research funding. Young faculty who joined Metallurgy departments in late nineties or new millennium after doing their Ph.Ds/ Post Doctorates in U.S. or European universities were already drifted towards Materials Science and had little interest in conventional process metallurgy areas. They, on joining the departments, started campaigning for changing the curriculum to include even more Materials Science oriented courses. This further curtailed not only the conventional process metallurgy courses but also some the more fundamental courses like Thermodynamics, Phase Equilibria, Heat Treatment, etc. Changes in curriculum also led to initiation of an intense debate within several Metallurgical Engineering departments to appropriately change the name of the department to reflect the true nature of Materials Science component of the curriculum. As a result, by the end of the first decade of the new millennium almost all IITs, NITs and several other Metallurgical Engineering departments in the country changed the name to Metallurgical and Materials Engineering. IIT Bombay changed its department to Materials Science and Materials Engineering, IIT Kanpur to Materials Science and Engineering. Among the new IITs having undergraduate program in metallurgy, IIT Gandhinagar has named its program as Materials Science and Engineering, IIT Hyderabad as Materials Science and Metallurgical Engineering, while all others as Metallurgical and Materials Engineering.

Present Status of Metallurgical/ Materials Engineering Curriculum

It was not that the changes in the curriculum were taking place only at the departments' level, there were major changes even in the common core of undergraduate engineering education to take into consideration the changing technological scenario all around as well as the aspirations of the young budding engineers. In a way there has been a change in paradigm of engineering education – provisions for UG degree with multiple options like, engineering degree with minors or with major or honours in the same discipline, or various duel degree options are made available. We shall not discuss these various degree options here because of time and space constraints. In what follows is an analysis of present basic undergraduate engineering curriculum in four of the older IITs - IIT Bombay, IIT Kanpur, IIT Kharagpur and IIT Madras; and two of the newer IITs - IIT Hyderabad and IIT Gandhinagar. Most of the other IITs and NITs have undergraduate curriculum falling in between.

As pointed out above also, younger generation of students is no longer interested in going through descriptive and repetitive courses requiring essentially memorizing details and data compilation. Rather, they are interested in more exciting newer science and technologies challenging their analytical skills. Not being sure of their future career path they want to keep their options open and do not want to be tied down to only their discipline related career options. Hence, at the undergraduate level they want to develop a wide knowledge base encompassing several disciplines including management, entrepreneurship, humanities and social sciences, etc. Several institutions are trying to meet their expectation by making the curriculum more flexible and having provision for several electives and open elective

slots in which the students are allowed to take almost any course that is being offered in the institute irrespective of their discipline. However, the level of flexibility varies from institution to institution. Just for the purpose of analysis, the entire undergraduate curriculum of any discipline is divided into five streams: courses pertaining to Basic Sciences, Engineering Sciences, Humanities and Social Sciences, Professional Streams (Engineering discipline) and Open Electives. Table 1 presents the percentages of courses in these five streams for the six IITs. It may be mentioned that IIT Hyderabad has introduced a new credit system for courses, called Fractional Academics. In this new system the entire semester is divided into 6 segments, each segment is of 2.5 to 3 weeks duration. Courses also have fractional credits ranging from 0.5 to 3. A typical 3 credit course has about 42 lectures and runs over the entire semester while a 0.5 credit course has 7 contact hours and runs over only during one segment of the semester. With this credit system, students can be exposed to a larger number of courses, though in many cases the exposure is somewhat shallow.

Table 1: Percentage of different categories of courses in UG curriculum of six different IITs

Course categories → / Institutes ↓	B. Sci	E. Sci	HSS	Prof	Op El
IIT Bombay	20	14	4.5	57	4.5
IIT Kanpur	18	20	13	38	11
IIT Kharagpur	16	20	12	52	-
IIT Madras	20	10	6	44	20
IIT Gandhinagar	23	21	19	27	10
IIT Hyderabad	16	13	9	58	4*

Nomenclature for course categories:

B. Sci - Basic Science Courses; E. Sci – Engineering Science Courses

Prof. – Professional (Discipline related) courses

HSS – Humanities & Social Science

Op El – Open Electives; * varies from department to department

Though the table clearly shows that the level of flexibility in the undergraduate curriculum varies in different institutions, one thing is apparent that the overall content of professional courses in most institutions has come down, in some cases only moderately while in some other substantially. One reason for this, as mentioned above too, is that several new courses like Introduction to Life Science; Introduction to Environmental Science; Basics of Design, Introduction to Entrepreneurship, etc. are becoming compulsory components of undergraduate curriculum. In most cases these courses are introduced either as Engineering or Basic Science courses. The extra slots needed for these courses are often created at the expense of Professional courses. Thus, the percentage of Professional courses in most institutes has shrunk.

Within the Profession also there are newer areas emerging and it is becoming essential to introduce these through compulsory or elective Professional courses. For instance, in Metallurgical/ Materials Engineering some of the areas which have emerged and have become prominent during the last one to two decades include Biomaterials, Nano-materials/ Nano-technologies, Electronic and Magnetic Materials, Computational Materials Science, Integrated Computational Materials Engineering (ICME) just to mention a few. Several of these are now being brought in as a part of the UG curriculum either as compulsory or elective courses by displacing some of the conventional courses in the older curriculum. Needless to say again. the worst affected are the courses in the area of Process Metallurgy/ Extractive Metallurgy – courses like Mineral processing, Extractive Metallurgy, Iron and Steelmaking, Non-ferrous Extractive Metallurgy, Foundry Technology, Heat Treatment. Contact hours for even discipline related Engineering Science courses like Thermodynamics, Kinetics, Transport Phenomena, etc. have been substantially curtailed. Therefore, many Metallurgy/ Materials departments have phased out earlier compulsory courses like Mineral Processing, Iron and Steelmaking, Non-ferrous Extractive Metallurgy and replaced these, for example, by just one course like 'Principles of Metal Extraction and Refining' with 3 lectures per week. In such a course there may be 8-10 lectures devoted to basic concepts of Mineral Processing, 8-10 lectures on general principles of pyro, hydro and electrometallurgy, 8-10 lectures on iron and steelmaking and 10-12 lectures on various nonferrous metal extraction practices. Some specific courses like 'Iron and Steelmaking' may be offered as electives which are not very popular among the students who prefer to take elective courses in the areas like Nanomaterials/ nanotechnologies, Advanced Materials, etc. There are not many takers for courses like Heat Treatment or Foundry as well.

CHALLENGES FACING THE PROCESS INDUSTRY

Because of the substantially reduced exposure to courses in the area of Process Metallurgy in general, and Mineral Processing and Extractive Metallurgy in particular, and also much reduced interest in doing research projects in these areas, the students graduating with Materials/ Metallurgical Engineering degree are not 'plant ready'. In many cases they are not even interested in taking up jobs in Process Industry as their preferred choice - it is largely true, at least, for the higher ranking students from IITs/ NITs and other premier institutions. Metallurgical Process industry, therefore, has to manage their plant operations through graduates of non-engineering background or graduate engineers of other engineering disciplines who are given short term on-job training to run the routine ongoing operations. They may be fine with routine operations but have problems whenever there are deviations from these practices/ or new procedures are to be adopted. This problem is becoming even more acute day by day as the younger faculty in the academic institutions is shying away from taking up research problems relevant to these areas because of ease of getting big sponsored projects in newer areas, and also not being able to attract the students to work on research problems in the areas related to process metallurgy. As a result, the research which was flourishing in academic institutions until about mid-eighties/ nineties is now getting extinct. Reduced research interest in these areas has a direct adverse effect on the kind of courses that are developed and offered in Process/ extractive metallurgy. While the academic institutions are drifting away from these areas, expanding process industry in the country desperately needs better exposed and trained young Metallurgists/ Materials engineers. Is there a way out to fill in this enlarging gap? A case study, briefly discussed below for a more or less similar scenario in Western Australia, may suggest some possible options to tackle this ticklish problem.

A Case Study of Keeping the Metallurgical Engineering Programs Not Just Alive but Growing and Thriving

The case study presented here pertains to Australia and is taken from a paper by Hannah and Hayes [3]. In early 2000 it was noted that the number as well as the quality (competencies) of graduating Mining, Mineral and Metallurgical engineers had reached a stage of great concern. The following three factors contributed to such a situation:

1. Declining enrolments
2. School closing
3. Changing competencies expected from graduating students.

The discipline was at risk of disappearing even in a country like Australia whose economics heavily rely on mineral processing and metal extraction industry. In spite of several corrective measures taken by the Government and several other agencies, not much changed until 2004 when some of the major companies in mineral industry came forward to change this scenario. At this point of time, in the state of Queensland which has some of the largest mineral and metallurgical industry, the only surviving Metallurgical Engineering degree program in the University of Queensland was about to be closed down. Some of the companies and the University decided to join hands together to ensure that not only the degree program survives, research activities and new interdisciplinary programs, like Chemical Metallurgical Engineering, thrive. This joint initiative established a sustainable program to provide the graduating students with appropriate technical breadth and depth which was needed for employment in the industry. The dual major with Chemical and Metallurgical Engineering not only made them suitable to take up jobs in mineral/ metallurgical industry but also gave them the option to go for jobs in other industries if they so wished. The participating companies not only provided the financial support to run and nurture the program, they also helped the faculty in taking up research problems which were relevant to the industry, and also closely worked with them. This significantly changed the overall research profile of the department. Further, companies' R&D personnel not only participated in the joint research activities but also actively participated in designing the curriculum and in class room teaching as and when required. This initiative led to substantial increase in enrolment as well as the interest of students in the program.

INDIAN SCENARIO AND INDIAN SOLUTION

In spite of the fact that both, the industry as well as the academia, have realized the importance of closely working together and every year several conferences/ workshops are organized to promote industry –academia partnership, the effective partnership between the two has mostly remained elusive. Industry does sponsor research projects to academic institutions, but these are far and few. Therefore these do not generate desired impact. During the last 6–7 years, Ministry of Steel, Govt. of India, has tried to prevent the phasing out of iron and steel component of undergraduate curriculum of Metallurgical/ Materials Engineering departments by creating Steel Professor Chairs and Steel Research Centers in several IITs, NITs and some other prominent institutions. This has definitely helped in slowing down the phasing out process in these institutions, but it would have been much more effective had there been participation of iron and steel industry as well. For example, in the ministry funded Steel Centers the research problems that have been taken up in most cases are more of routine academic type and quite often are not the priority problems of the industry. Also the review and monitoring of the performance of the Centers has been rather tentative.

There are examples, though not many, to show that whenever and wherever industry has given major research projects with targeted outcomes to institutions and have worked closely with the faculty, the research ambiance of that department has been positively impacted. Big projects create big research groups working on targeted research problems. This generates curiosity among other students of the department and several of them are motivated to explore similar research opportunities. This scenario also helps in promoting elective courses which otherwise are ignored by the students. IIT Bombay, IIT Kanpur and IIT Kharagpur are the institution where major targeted sponsored projects with close industrial participation have made positive impact in revitalizing otherwise dormant iron and steelmaking area in these institutions.

It is to be realized that even though in most cases the fresh Metallurgy/ Materials graduates are not 'plant ready', they are no less competent – they have some unique skills which may be effectively utilized once they are settled after their initial plant training and exposure. Because of the revised curriculum with higher interdisciplinary components, these graduates have been exposed to subject matters cutting across the disciplines boundaries. Hence, they have broader base and are better equipped to tackle problems requiring expertise cutting across one's own discipline. For example, a fresh student who has gone through a set of courses on Computational Materials Science and has exposure to topics like, Molecular Dynamics, Density Function Theory (DFT), Monte Carlo Simulation, is perhaps better equipped to tackle problems related to alloy/ material design, as compared to an earlier Metallurgy/ Materials graduate who might have gone through more rigorous courses on Phase Equilibria and Phase Diagrams. The industry has to have faith in them and appropriately empower them.

There is one more thing that the industry may do, and this for the students while they are still in their UG program. The young minds need to be exposed to, and given an opportunity to use their inhibited enthusiasm and new skill-sets to solve some real challenging metallurgical problems - we need to ignite their curiosity and excite them about the challenges of process metallurgy early enough in their undergraduate program, preferably at the second/third year level itself, when they would not have done many metallurgy/ materials courses. At this stage, using their unique skills to search for a solution without having the fear of failure, they are likely to come up with some out of the box solutions. The challenge to find solution to these industrial problems may either be through some kind of an open competition or through working in the project mode - small problems can be taken up as the individual projects while somewhat bigger problems can be done as group projects.

Such a scheme, however, will be effective only when some R&D personnel of industry are available for regular interaction with the students working on these problems. This is where the approach used by industrial groups in Queensland may be emulated. That is, the clusters/ groups of similar type of industry may collaborate with an institution having undergraduate degree program in Metallurgical/ Materials Engineering and motivate the faculty to initiate research in the areas which are relevant to their industry. They may also help in designing and offering of the new elective courses in the relevant areas. This, of course, will require financial as well as manpower commitments on the part of industry. Thus, if several such industry clusters collaborate with different academic institutions, there is a possibility that several of the students from these institutions at least will not only be 'plant ready' on graduation but even better prepared to solve plant problems. Even if only 10-20 percent of the Metallurgy/ Materials Engineering graduates are drawn towards Process Metallurgy, they may do wonders.

One more new avenue is now becoming available which some of the large industries, at least, can take advantage of. Government of India has recently set up Research Parks in 5-6 institutions – this number is likely to be doubled in the near future. Some of the Research Parks, e.g. at IIT Madras, IIT Gandhinagar, IIT Bombay, are already functional. These Research Parks provide opportunity to an industry to rent space in the Park to set up its own R&D unit to be run and managed by its own R&D personnel. Such a R&D unit has access to Institute's R&D infrastructure on pre-agreed terms and conditions. Not only that the R&D unit can interact with faculty and students of the Institute in seamless manner and collaborate with them on research problems of mutual interest, qualified R&D persons can also participate in the Institute's regular academic program through joint supervision of Ph.D./M.Tech theses and B.Tech projects, and contributing towards teaching of compulsory or elective courses. While the continuous presence of industrial personnel on campus and their regular interaction with faculty and students keeps the motivation

and interest of the latter in industrial problems high, the R&D unit can take full advantage of state of the art research infrastructure that exists in many institutions and also the available expertise of highly talented faculty and students. This is a win - win situation for both the industry and the academic institution.

CONCLUSIONS

It is a fact that the undergraduate engineering curriculum in India is undergoing a paradigm change and becoming broader based by including courses which cut across the discipline boundaries. This, along with several new areas that have emerged and are emerging on regular basis in broad discipline of materials, has necessitated major changes in the undergraduate curriculum of Metallurgical/ Materials engineering in most institutions in India. The number of courses pertaining to areas like Mineral Processing, Process Metallurgy, in general, and Extractive Metallurgy in particular have been substantially curtailed. Not only the courses but also the research in these areas is almost getting extinct. Consequently, the students graduating from these departments neither have the adequate exposure to the subject matters which are essential for several of these areas, nor the interest to fill this gap. Hence, it is not surprising that they are not 'plant ready'. Further, it is not that only the industry needs well trained metallurgists/ materials graduates, even the academia and R&D need motivated students to purse academics in several of these areas of national interest.

One effective way to rejuvenate some of these phasing out areas would necessarily require industry joining hands with academia with all seriousness and work closely in the academic environment to promote industrial research in the academic institutions and also actively participate in their teaching programs. Medium to large scale industrial houses may explore the possibility of setting up their R&D units in the institutions which already have functional Research Parks or likely to have them soon. This will automatically ensure their active and continuous collaboration with the academic institution.

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ANNEXURE 1

List of Institutions in India offering undergraduate degree in Metallurgical/Material Engineering

S.N.	Institute Name	S.N.	Institute Name
1	Indian Institute of Technology Bombay	17	Visvesvaraya National Institute of Technology Nagpur
2	Indian Institute of Technology Kanpur	18	National Institute of Technology Jamshedpur
3	Indian Institute of Technology Kharagpur	19	National Institute of Technology Srinagar
4	Indian Institute of Technology Madras	20	Malaviya National Institute of Technology Jaipur
5	Indian Institute of Technology BHU	21	Maulana Azad National Institute of Technology Bhopal
6	Indian Institute of Technology Roorkee	22	Indian Institute of Engineering Science and Technology Howrah
7	Indian Institute of Technology Gandhinagar	23	Jadavpur University Kolkata
8	Indian Institute of Technology Hyderabad	24	College of Engineering Pune
9	Indian Institute of Technology Roper	25	Thapar Institute of Engineering and Technology Patiala
10	Indian Institute of Technology Bhubaneswar	26	Punjab Engineering College Chandigarh
11	Indian Institute of Technology Indore	27	Jawaharlal Nehru Technological University Hyderabad
12	National Institute of Technology Warangal	28	University of Hyderabad Hyderabad
13	National Institute of Technology Durgapur	29	Sathyabama Institute of Science and Technology Chennai
14	National Institute of Technology Surathkal	30	Mahatma Gandhi Institute of Technology Hyderabad
15	National Institute of Technology Tiruchirappalli	31	Bangalore University Bangalore
16	National Institute of Technology Raipur	32	National Institute of Forging Technology Ranchi

33	Birsa Institute of Technology Sindri, Dhanbad	44	Indus University Ahmedabad
34	University Institute of Engineering and Technology Kanpur	45	Chhattisgarh Swami Vivekanand Technological University Bhilai
35	Indira Gandhi Institute of Technology Sarang	46	Barkatullah University Bhopal
36	Jawaharlal Nehru Technological University Kakinada	47	Andhra University Vishakhapatnam
37	O P Jindal University Raigarh	48	Defence Institute of Advanced Technology Pune
38	Surendra Sai University of Technology Sambalpur	49	School of Engineering and Technology, Jain University Bangalore
39	Manipal Institute of Technology Manipal	50	Parala Maharaja Engineering College Berhampur
40	PSG College of Technology Coimbatore	51	YSR Engineering College Proddatur
41	Govt. College of Engineering Salem	52	Yogi Vemana University Kadapa Jagatguru Dattatray College of Engineering Indore
42	Govt. Engineering College Gandhinagar	53	M S University Vadodara
43	Gujarat Technological University Ahmedabad		

72nd ANNUAL TECHNICAL MEETING: A REPORT

In order to attain the growth in metal and mining industries, self-sufficiency in new technology is an absolute necessity. In this sector, lot of deliberation can be made possible through intensive collaboration, skill development and knowledge dissemination. At this juncture 72nd Annual Technical Meeting (ATM) proved to be an ideal platform to address all the above issues. This year, the Indian Institute of Metals organised the 56th National Metallurgists' Day (NMD) and 72nd Annual Technical Meeting (ATM) during 14th to 16th November, 2018 at Kolkata, the capital city of West Bengal, India.

As a part of the annual event, ATM presentations were organised on 15th and 16th of November 2018, where eminent speakers from academia, research institutes and industries showcased their recent findings in different areas. The scope of ATM encompassed modelling, mineral extraction and beneficiation, manufacturing of ferrous, non-ferrous and other materials, development and characterization of products, environment and other sustainability issues, corrosion, tribology, surface engineering, joining technologies, casting, powder metallurgy, non-destructive testing, emerging technologies, industry automation etc.

On 15th Nov'18 inauguration of 72nd ATM took place in the presence of President IIM, senior officials of IIM and key organizers of NMD 2018. This was followed by three plenary lectures by Professor C Barry Carter (Univ. of Connecticut, USA), Mr. R Petkar (CTO, Tata Motors) and Dr. Peter Blauhauff (Ex-CEO, Deutsche Shell Holding GmbH) on following topics respectively.

- 'In-Situ and Operando TEM for Materials Analysis'
- 'Future of Electrical Vehicles and its changing effect on Metallurgical Industries in India'
- 'Sustainability and Safety'

Post these, the stage was set for the two-day marathon of technical events – the oral presentations, the e-poster presentations and the Metallography contest. This year's ATM had multiple parallel technical sessions for oral presentations which covered wide ranging topics such as Raw Materials, Process Metallurgy, Products, Non-Ferrous Metals, Energy-Environment-Waste Utilization, Advances in Materials Science and Industry 4.0. The technical sessions also had some 55 keynote speeches by eminent speakers from industry and academia. The organizers received more than 700 contributory abstracts with the mentioned themes, out of which around 350 were selected for oral technical sessions while others were presented in e-poster competition. The poster competition was first time being conducted in electronic form with nil posters but all being presented on wide TV screens. The national-level Metallography contest, organized as a part of IIM's continuing tradition to promote excellence in Metallography received more than 100 entries in four categories of Light and Electron Microscopy.

The technical sessions continued till the third and last day – 16th Nov'18. The three-day event concluded with a valedictory function. The best entries in all the major competitive categories received prizes for their worthy achievements. NMD – ATM 2018 witnessed a significant rise in participation from all segments, particularly from the student community.

With the help of sponsors and guidance of IIM's senior officials, the organizing team of NMD – ATM 2018 is proud for having put up a successful show.

ATM Awardees

Metallography:

Sl No	Name	Affiliation	Theme
1	Partha Pratim Sarkar	RDCIS	Optical micrograph
2	Monalisa Char	JB Centre of Excellence, Jagadis Bose National Science Talent Search, Kolkata-700107, India	SEM
3	Sourabh Chatterjee	Tata Steel	SEM
4	Shreya Mukherjee	IIT KGP	SEM
5	Ramendra Kumar Gupta	VNIT, Nagpur	TEM
6	Narayana Murty SVS	VSSC	TEM

E-Poster :

Sl No	Name	Affiliation	Theme	Title
1	Manas Srivastava	IIT BHU	Advances in Materials Science	Magnetic nanoparticles of LixFe3-xO4 for controlled hyperthermia application
2	Mohammed Rasul	JSW Steel Limited, Salem Works	Advances in Materials Science	Simulation and Optimization of groove rolling process for long products
3	Barnasree Chanda	IIT KGP	Advances in Materials Science	Evolution of eutectic microstructure in high entropy CoCrFeNiNbx alloys
4	Arijit Mitra	IIT KGP	Advances in Materials Science	Effect of Microstructure and Bulk Macro-texture on the Electrical Resistivity of Electrodeposited Sn-Cu Lead-free Solder films
5	Rajasekhar Reddy Seelam	IIT Hyderabad	Advances in Materials Science	Microstructure and texture of severely warm-rolled nano-lamellar AlCoCrFeNi2.1 Eutectic High Entropy Alloy

6	Souvik Das	Tata Steel	Products	Breakage of High Carbon Spring Steel Grade Steel Wires during Manufacturing: A Metallurgical Investigation
7	Poulami Chakraborty	BARC	Products	Effect of alloying elements on the corrosion behavior RAFM steels in Lead-Lithium eutectic
8	Antariksh Gupta	RDCIS	Process Metallurgy	Simulation of Vortex Formation during Tundish Teeming
9	Aluru Sekhar	IIEST	Non Ferrous	Cyclic Deformation Response of Artificially Aged AA6063 Alloy
10	Yazar K U	IISC	Non Ferrous	Normal and dwell fatigue behavior of a near alpha titanium alloy – IMI 834
11	Bimlendra Roy	RDCIS	Products	Introduction of die lubrication system at Wheel and Axle Plant
12	Neveen Singh	JSW Steel Limited, Vijayanagar Works	Process Metallurgy	Developing robust Real Time Hearth Liquid Level (HLL) model in Blast Furnace and strategies adopted to improve accuracy of prediction through Artificial Intelligence

Oral :

Sl No	Name	Affiliation	Theme	Title
1	Shreyas Puttige	Tata Steel	Industry 4.0	Data driven Turndown Phosphorous prediction model for BOF steelmaking process using machine learning methods
2	Anrin Bhattacharyya	Recyron Engg and Consulting e.U.	Energy, Environment and Waste Utilization	RECYRON®: Idea to Innovation to Technology in Zero-Waste Ironmaking
3	Sudipta Patra	Jindal Stainless (Hisar) ltd	Products	Development of high strength high toughness alloy steel for defence application
4	Jay Chakraborty	CSIR NML	Products	Cementite dissolution in cold drawn pearlitic steel: An overview
5	Argha Dutta	VECC, Kolkata	Advances in Materials Science	Microstructural Characterization of Proton Irradiated Fe-2.25Cr-1Mo Using X-ray Diffraction Line Profile Analysis
6	Esakkiraja Neelamegan	IISC	Advances in Materials Science	The Concept of Pseudo-binary and pseudo-ternary diffusion couples in multicomponent systems
7	M Varma Raju	JSW Steel Ltd	Raw Materials	Comparative studies on High-Gradient Magnetic Separation of Ultrafine iron ore Particles with Medium and Finer Matrix
8	Shivendra Sinha	CSIR NML	Non Ferrous	Facile leaching of Cu, Ni and Co from complex sulphides using n-Hexadecane as Oxygen Vector
9	Ubayadullah M	JSW Steel Ltd	Process Metallurgy	Strategies to Increase Pulverized Coal Injection (PCI) Rate in Larger Blast Furnace with High Slag Rate
10	J Pal	CSIR NML	Process Metallurgy	Development on pelletization for reducing energy consumption and quality improvement

G S Tendulkar Award :

Sl No	Name	Affiliation	Theme	Title
1	Deepu John	IIT Madras	Products	Simulation of microstructure evolution for DP steel welding

PK Dasgupta Award :

Sl No	Name	Affiliation	Theme	Title
1	Sudip Acharyya (Ferrous)	RDCIS	Raw Materials	Effect of selective granulation on internal microstructure and reducing quality of iron ore sinter
2	Dewika Mishra (Non Ferrous)	IIT Bombay	Advances in Materials Science	Wear damages and effects of graphene based lubricants during reciprocating sliding motion at high contact pressures

Tata Steel chooses CMI's technology for its new CRM Complex in Kalinganagar

Tata Steel has awarded CMI Industry METALS a contract for three state of the art processing lines: 2 Continuous Galvanizing Lines (CGL) & 1 Continuous Annealing Line (CAL). All three high-end lines are to be supplied to the client's site at Kalinganagar in the Jajpur district of Orissa. The order placed with CMI for three processing lines, that are to provide the client with the very latest technology, will allow Tata Steel to produce skin panels for car outer bodies, helping it retain leadership among domestic suppliers to high-quality segments like the auto and white goods sectors. As such, all three lines are central parts of the phase two expansion of the client's steel plant, and are to increase the annual galvanized steel production by 1 million tonnes.

Decisive factors for choosing CMI for this project were the company's extensive experience in steel processing lines, but also the high process security of the plant concept, which features the full spectrum of CMI's process technologies: Multi-stage cleaning section, Vertical annealing furnace (incl. CMI's L-Top math model and jet cooling system), Air-Knife system, APC Blowstab low vibration cooling system, Inline skin pass mill and Tension leveller, Chemical roll-coat post treatment, Side trimmer, Exit shear.

The material grades will range from deep-drawing steels, hot-formed and high-strength steels, to dual-phase and complex-phase steels. Besides the traditional Gi coating, one of the new lines is designed to also process aluminized (AluSi) coatings, while the second line is to also apply galvannealed (Ga) coatings. The order covers the engineering, procurement and supply, as well as the supervision of the erection and commissioning.

This is the 3rd contract that Tata Steel entrusts to CMI Industry METALS in the past 6 years. After the recent modernization of SEGAL, Tata's high-end automotive line in Belgium, this is the second order that Tata places with CMI in the framework of its automotive steel production.

Strategic Research Institute, Steel Guru

SAIL expects to supply 10 lakh tonne steel for railways tracks in 2018-19: MoS Steel

Indian Railways would require 14 lakh tonne of steel during 2018-19, of which state-run SAIL expects to supply 10 lakh tonne, Parliament was informed.

"SAIL expects to supply 10 lakh tonne of steel in 2018-19 and 12 lakh in 2019-20 to Indian Railways for doubling of rail lines, gauge conversion, new lines and track renewal works," Minister of State for Steel Vishnu Deo Sai said in a written reply to the Lok Sabha.

The Railways has indicated its demand of about 14 lakh tonne during 2018-19 and 17 lakh tonne in 2019-20, he informed the Lower House. In India, only two steel companies manufacture rails. Steel Authority of India Ltd (SAIL) manufactures 260-metre-long rails at its Bhilai Steel Plant, and Naveen Jindal-led Jindal Steel and Power Ltd (JSPL) makes 121-metre-long track rails at its Raigarh unit and can weld these rails up to 480 metre.

Indian Railways is looking at 4,000 km of track renewal in each financial years 2018-19 and 2019-20. It had invited the global tender for procuring around 4.87 lakh tonne of rails after anticipating that SAIL would not be able to supply the required amount of rails.

The Times of India

Ministry of Steel initiative of Make in Steel - Make in India

The National Steel Policy - 2017 envisages creation of 300 million tonnes of steel capacity in the country by 2030-31 as against existing capacity of about 137 million tonnes. The estimated import of plant and equipment, for reaching 300 million tonnes capacity, will be around USD 25 billion. Further, it is estimated that at 300 MT capacity level, India will have to spend about USD 500 million annually for import of proprietary and other spares. Ministry of Steel organized a Conclave on "Capital Goods in Steel Sector: Manufacturing in India" in Bhubaneshwar, Odisha on 23.10.2018. The Conclave is an initiative to promote domestic capacity and capability building and manufacturing of capital goods in steel sector. To accomplish the Vision of the Government of India, SAIL signed MOUs during the Conclave with Capital Goods manufacturers' (BHEL, HEC and MECON) so as to give a boost to indigenization of manufacturing of Capital goods related to steel sector.

Award Scheme for Secondary Steel Producers

Ministry of Steel has instituted an Award Scheme for Secondary Steel Producers in the year 2018, to give recognition for their contribution in the national economy and to encourage these producers to achieve high standards of efficiency, quality, safety & economy in operation and also to promote innovation, waste utilization, reduction in GHG emission etc. The awards were given away at the Secondary Steel Sector Conclave held on September 13, 2018 for the performance year 2016-17.

Domestically Manufactured Iron and Steel Products (DMI&SP) Policy

The policy of preference to domestic manufacturers of iron and steel products (DMI&SP) which was rolled out in May, 2017 has brought an estimated savings of around Rs.8500 crores worth of foreign exchange.

Steel Research and Technology Mission of India (SRTMI)

Government has facilitated setting up of an innovative institutional mechanism namely SRTMI to promote joint collaborative research projects of national importance in iron & steel sector in India. This is an industry driven platform and the initial corpus is being funded by the major steel companies. SRTMI has been registered under the Societies Registration Act on 14th October 2015. SRTMI is actively interacting with steel companies, research labs & academia to spearhead research for the iron & steel sector.

Budget for R&D

Ministry of Steel is financing the promotion in Research and Development in Steel Sector, an R&D scheme. During the year 2018, 10 R&D projects have been approved with total cost of Rs 43.87 crore with financial assistance of Rs. 40.79 crore from the Government budget. 25 R&D projects are in progress. Ministry of Steel is also funding 50% (Rs. 5.52 crore) in 3 R&D projects being pursued under the IMPRINT Scheme of MHRD with a total cost of Rs 11.04 crore.

R&D through Steel Development Fund

During the year 2018, 9 on-going R&D projects were pursued with under the SDF assisted R&D scheme.

Centre of Excellence in Steel Technology

Ministry of Steel is providing financial assistance for setting up of Centre of Excellences for creation of world class facility for metallurgical engineering and also for development of human resource for the steel sector. Such facilities are promoting R&D for the iron & steel sector and also generate skilled manpower for the sector. Four such Centers have been set up/ approved at IIT Kharagpur, IIT Bombay, IIT, BHU and IIT, Madras.

Quality control of Steel and Steel Products

Ministry of Steel is the leading Ministry with maximum coverage of products under the BIS certifications marks scheme. More than 85% steel products in the country are covered under Mandatory Quality Control Orders. These orders prohibit, import, sale and distribution of substandard steel products. This ensures better health & safety standards for end-users. Ministry of Steel has so far covered 47 carbon steel and 6 stainless steel products standards under the Mandatory BIS Certification scheme. Government has been facilitating supply of quality steel for

critical end-use applications such as infrastructure, construction, housing and engineering sector.

NEDO Model Projects

NEDO is the New Energy and Industrial Technology Development Organization (NEDO) established as a Japanese Governmental organization in 1980 to promote the development and introduction of new energy technologies and research and development of industrial technology. NEDO is active in a wide variety of areas as one of the largest public research and development management organizations in Japan. With the aim of raising the level of industrial technology, NEDO pursues research and development of advanced new technology. Drawing on its considerable management know-how, NEDO carries out projects to explore future technology seeds as well as mid- to long-term projects that form the basis of industrial development. It also supports research related to practical application. Under the NEDO model projects, Ministry of Steel, with financial assistance from Government of Japan, facilitated setting up of model projects in integrated steel plants to promote energy efficient, clean and green technologies. During the period April 2014-March 2018, one model project on Energy Management System has been approved and is under implementation at ISP Burnpur of SAIL.

UNDP Project

Ministry of Steel in association with UNDP and Aus Aid have implemented the project "Up scaling Energy Efficient Production in Small Scale Steel Industry in India". Through this project, skill development training was imparted to implement energy efficient technologies in 283 re-rolling mills and 4 induction furnace units for improvement of productivity, reduction in energy consumption and GHG emission. This resulted in average 24% reduction in energy consumption in these units.

Strategic Research Institute, Steel Guru

NGT orders reopening of Vedanta copper plant in Tamil Nadu's Thoothukudi

The National Green Tribunal has set aside the Tamil Nadu Government's order closing down the Vedanta-owned Sterlite Copper factory in Thoothukudi, Tamil Nadu. The Tribunal has also directed the state pollution control board to renew a key licence, Consent to Operate, and remove other hurdles subject to fulfilment of certain conditions, within three weeks from now. The Tribunal has also ordered for restoration of power supply to the factory, subject to certain conditions. On May 23, the state pollution control board had suspended power supply after it claimed to have found production-related activity inside the factory, at a time the Sterlite Copper plant hadn't had a licence to run the unit. The NGT order is the culmination of a legal battle for over 6 months. Sterlite Copper had moved the NGT well over a month after the closure order by Tamil Nadu in May this year. In the order, the Tribunal had adjudicated on the legality of the Tamil Nadu pollution control board to refuse a renewal of the Consent to Operate, the first roadblock for Sterlite Copper that culminated in its shutdown in May this year.

The court has also said Sterlite Copper should, on "precautionary principle," take a series of steps for "safeguarding environment." The factory has been directed to spend Rs 2.5 crore for its faulty handling of 3.5 lakh tonnes of copper slag near the factory. The Vedanta-owned Sterlite Factory was shut in 2013 on complaints of causing harm to the environment. It was reopened after the Supreme Court ruled in its favour but directed it to spend Rs100 crore for the environment. In recent judgment too, the NGT has directed Sterlite to implement its promise of spending another Rs 100 crore for the environment. The Co is happy that all those affected by the closure will get back their source of livelihood and the town of Thoothukudi will revert to normalcy. They will study the order in detail and shall take all steps required to restart the operations as per guidelines given by the honourable court.

The Economic Times

Automakers should increase use of galvanised steel: Study

A study commissioned by the International Zinc Association has suggested that automobile manufacturers increase the adoption of 'galvanised steel' to ensure enhanced durability of cars. The study, led by former IIT Bombay Department of Metallurgy Engineering department professor Anand Khanna, said there could be 20 per cent higher risk of death due to rusty cars and stressed the importance of protecting steel against corrosion. It said Indians spend nearly 12 hours more of their time behind the wheels on an average every day leading to higher risk of life. About 500 cars between five and 10 year old across hatchback and sedan segments and based on average Indian family usage were used for the study. The findings emphasised the need for increased adoption of galvanised steel in automotive industry, especially in coastal areas, to increase the durability of cars. International Zinc Association consultant Dough Rourke said one of the underlying insights that emerged from the study was the need for increased galvanisation of automotive parts. The study brings into light the striking difference in galvanisation of body parts in cars manufactured for domestic consumers which stands at 15-30 per cent when the same stands at 70 per cent for those cars shipped out of India", he said. "The study is an eye opener for car owners in the city as it clearly indicates the causes for imperfection that arise owing to climatic conditions," Khanna said. He expressed confidence that Chennai being an auto manufacturing hub, the companies will consider the insights from the study.

The Economic Times

EVENTS CALENDAR 2019

February

22

IIM Kolkata Chapter is organizing the International Seminar on "Prospects and Challenges in Metallurgical & Allied Industries with Special Emphasis on Quality, Safety and Environment" at hotel Floatel on ganges, Kolkata.
Convener: tapchak2014@gmail.com,
(M) : 9230029517

April

11-12

IIM Mumbai Chapter in association of Indian Institute of Technology, Bombay, organizing a Symposium on "Critical Non-Ferrous Metals: Establishing the value chain".
Convener: Dr Vilas Tathavadkar, Aditya Birla Science & Technology Co Pvt Ltd.

Kalpakkam and Chennai Chapters

The 10th Placid Rodriguez Memorial Lecture was organized on 5th October 2018 at IC&SR Auditorium, IIT Madras, Chennai, jointly by Kalpakkam and Chennai Chapters of Indian Institute of Metals. Prof.Srinivasa Rao Bakshi, Chairman, IIM Chennai Chapter welcomed the gathering and Dr. M. Kamaraj, Member, PRML Committee, briefly dwelt upon the genesis of Dr. Placid Rodriguez Memorial lecture and the details of the series of lectures conducted since 2009. Dr. U. Kamachi Mudali, Vice President, IIM, Chairman & Chief Executive, HWB, Mumbai in his presidential address recollected the significant contributions of Dr. Placid Rodriguez to the materials development for Fast Breeder Reactor programme of the country and in shaping up human resources for defence programmes and academic institutions. Dr. R. Divakar, Chairman, IIM Kalpakkam Chapter introduced the PRML 2018 speaker Dr. Samir V. Kamat, the Director General of Naval Systems and Materials, working on the development of various advanced materials for defence applications. In his PRML 2018 lecture titled "MATERIALS FOR FUTURE DEFENCE SYSTEMS: AEROENGINES" Dr. Samir V. Kamat stressed that the materials for future defence systems will be required to satisfy diverse requirements in terms of speed, strength, precision, survivability, signature, materials selection, cost, weight, and commonality. The speaker focused on materials technologies for military gas turbine aeroengine which is one the most complex and cutting edge defence system powering all fighter aircraft and where advancement in materials have the most significant impact. He presented the three main fronts along which the improvement and development of materials for aeroengine applications is developing: the improvement of current material properties by refining composition and novel processing methods for new applications; the application of current materials in new and novel structures and the development of new materials. Dr. Samir V. Kamat summarized his excellent talk by stressing the significance of Integrated Computational Materials Engineering (ICME) in converting material capabilities to delivery of hardware for military aeroengines as well as other defence systems. The lecture was very well received by the audience comprising scientists, and young research scholars who participated in the event. Dr. U. Kamachi Mudali presented the PRML memento to Dr. Samir V. Kamat and the programme concluded with a vote of thanks by Dr. Rani P. George, Convener, PRML 2018, followed with high tea.

Dr. Samir V. Kamat delivering PRM Lecture

Lecture notes released by guest of honor Dr. V. Jagadeesh Kumar, Dean (Academic Courses), IIT Madras

- Report from Secretary, IIM Kalpakkam Chapter

Visakhapatnam Chapter

The Annual General Body meeting (AGM) of Visakhapatnam Chapter was held in Ukkunagaram on 6th November, 2018.
The Executive Committee for the year 2018-19 was elected, which is as follows:

Port folio	Name	Designation
Chairman	K. Ghosh	ED(Mills & Logistics), RINL-VSP
Vice Chairman	Srinivasa Rao	HOD, Dept. of Metallurgical Engg., AUCE
	Raffi Mohammed	HOD, Metallurgical Engineering Department, NIT, Andhra Pradesh
Secretary	Utpal Kumar	AGM(BF), RINL-VSP
Jt. Secretary	S. Chakraborti	AGM (R&D), RINL-VSP
	D.S. Padma Priya	AGM (QA&TD), RINL-VSP
Treasurer	Mahesh Kumar Sharma	AGM (R&D), RINL-VSP
Treasurer	N. Tata Rao	Manager (CRG), RINL-VSP

Vijaynagar Chapter

The IIM Vijaynagar chapter celebrated the National Metallurgist Day on 28th Nov, 2018 at JSW Steel Vijaynagar works in Bellary Karnataka. The welcome address was given by Mr. L R Singh, Secretary, IIM-Vijaynagar Chapter. He also presented the chapter highlights. More than 250 engineers from the chapter attended it. Several awards were given to the promising Metallurgists, Departments with maximum new member additions and paper & poster award winners of NMD - ATM 2018 held at Kolkata. In this event, chapter started Shri O P Jindal Memorial lecture series where the Inaugural and maiden lecture was delivered by Dr. Sanak Mishra, Senior Advisor, Mishra Dhatu Nigam Limited (MIDHANI), Hyderabad, on "Advances in Steel Technology in the Last Fifty Years" which was highly appreciated. The chapter's website, https://iimvjnr.jsw.in, was also launched on this occasion.

Dr. Sanak Mishra delivering Shri O P Jindal Memorial lecture

Audience

Durgapur chapter

The Annual General Body meeting (AGM) of Durgapur Chapter for the year 2018-19 was held in Dhatu Bhawan, Durgapur on 2nd December, 2018. The meeting was preceded by 'Prof. S C Dasgupta Memorial Lecture' which was delivered by Sh. L Badu, Jt. Secretary on "Next Generation Reactor Vessels and its Heat Treatment Technology". After that, Treasurer presented description of activities and details on financial status, income expenditure details etc. The audit report was placed and accepted by all who were present.

The elected Executive Committee for the year 2018-19 is as follows:

Port folio	Name	Designation
Chairman	TB Singh	ED (Proj), DSP
Vice Chairman	S K Dubey	GM (BF), DSP
	Shibasis Basu	GM (SMS), DSP
Hony. Secretary	Lohitendu Badu	DGM (RCL), DSP
Jt. Secretary	SK Kanoje	AGM (SP), DSP
	Ajeet Kumar	Mgr (BF), DSP
Hony. Treasurer	Saurabh Ghosh	Mgr (SMS), DSP
Jt. Treasurer	Dr Dibyendu Mukherjee	Mgr (MSM), DSP

Inauguration of Bharuch Chapter

The 55th chapter of The Indian Institute of Metals was inaugurated at Sad Vidya Mandal Institute of Information Technology, Bharuch on 15th December 2018 by Shri Ravi Arora, IAS, District Collector Bharuch, Gujarat. Mr. Sanjay Sarkar, Chairman-IIM-Bharuch chapter welcomed everybody. In his welcome address, he informed the audience "The chapter will benefit local industries and students who want to take advantage of innovation in metal industry." He encouraged the students to make use of the platform that IIM provides to fine - tune and showcase their skills and talent. Mr. Kushal Saha, Secretary General, Indian Institute of Metals, said "The institute is to promote metallurgy in the country. The chapter helps small, medium or large entrepreneur for their solutions. Government of India is also supporting institute by announcing various awards." Shri Ravi Arora, in his inaugural address spoke about the importance of IIM Bharuch chapter. Bharuch has lot of potential for such institute because of several industries like Hindalco, Jhagadia Copper, Steelco etc. The function ended with a vote of thanks by Mr. Raghavendra Adiga, Secretary-IIM-Bharuch chapter.

Past Events

12th India Energy Summit

The Indian Chamber of Commerce (ICC) has been organising Energy Summit every year. The 12th India Energy Summit was held at New Delhi on 13th and 14th November 2018. The Theme of the Summit was "Clean Energy in Every Home. Shri Ajay Kumar Bhalla, Secretary, Ministry of Power, was the Chief Guest of the Summit.

At the outset, Shri Anil Razdan, Former Secretary, Ministry of Power and Chairman of ICC National Expert Committee on Energy, delivered the welcome address. In his address, Shri Razdan mentioned that we are moving to the phase of energy transformation. We are well ahead of meeting the renewable energy targets. He mentioned that the share of renewable energy in our country has increased from 6% to 10% in the last 4-5 years. Our country is the third largest importer of oil. Coal will continue to be our source of energy for another decade. At present, we are importing 85-87% of solar equipment. We are making good progress in the wind sector. We have to think about alternative fuel of coal.

Shri Rudra Chatterjee, President ICC, in his address, stated that if we have to grow at 7% per annum, our energy requirement will increase in the range of 3% to 5% per year. Presently coal is the main source of energy in our country. We have to think about increasing the share of renewable energy sources to meet our energy requirement.

Shri Gurpreet Chugh, Managing Director, ICF, informed that energy is a basic need for economic development. We should give thrust on clean energy. Electricity accessibility has improved but access to clean cooking fuel remains an issue. 60% of our population is deprived of access to clean cooking fuel. Renewable energy capacity addition is visible but share of renewable energy in electricity mix has to increase. Our focus areas should be improvement in energy efficiency, how to green the grid and fuel substitution in cooking.

Shri Gurdeep Singh, CMD, NTPC, stated that NTPC is the largest public utility in power generation in the country. By 31st December 2018, all the villages in the country will be electrified. He talked about maximising the usage of induction cooking system. He also spoke about electric vehicles. Per capita electricity consumption is 1100-1200 kwh and soon it will increase three fold from this level. He emphasised that incremental capacity should come from cleaner sources. We should improve our energy efficiency. We are moving at good speed for implementation of Paris agreement to reduce the carbon footprint. Our focus should be on renewable sources of energy. We are working on a policy of blending coal usage with renewable sources of energy and utilisation of bio-mass.

Shri Ajay Kumar Bhalla, Secretary, Ministry of Power, stated that our aim is that 50% of installed capacity in power sector should come from renewables. A number of measures have been taken by the Government to reduce emission of carbon. The aim of the Government is to provide electricity in every house by 31st December 2018. Bihar and Jammu & Kashmir have already electrified all the households. Gas is a source of clean energy. We are thinking of energy mix with coal and renewables. We cannot shut all coal plants. We are gradually replacing the inefficient coal plants. Incremental addition of Renewables has to come from solar and wind sectors. Wind projects are coming up. The government is doing a lot of work in energy saving. Efforts are being made by the Government to reduce carbon emission.

Shri Ganesh Chaudhary, Co-Chairman, ICC National Expert Committee on Energy and MD & CEO, Vikram Solar, delivered the concluding address. He observed that Renewable Energy has to take centre stage in energy sector. We have to work on energy efficiency measures. Our focus should be on cleaner generation of energy.

Shri Ajay Kumar Bhalla and other dignitaries present on the dais released the Knowledge Report prepared by ICC and ICF on Energy Sector.

This marked the conclusion of the inaugural session of the Summit.

The Plenary Session I was devoted to SAUBHAGYA: 24x7 Power for All.

Dr PV Ramesh, CMD, REC Ltd, stated that the major constraint in the power sector is about the inadequacy in robustness of the existing infrastructure. We need to take special measures to strengthen the existing infrastructure in the energy sector. The objective of Saubhagyaa is to extend power to all households in the country. Around one lakh fifty thousand houses are being electrified everyday. Bihar and Jammu & Kashmir have electrified all the houses in their states.

Shri Pankaj Batra, Former Chairman, CEA, mentioned that electricity is a basic need. It facilitates progress in all sectors of the economy. However, UP and Assam are lagging behind in this direction. The states have inadequate transmission facilities. This area needs to be strengthened.

Shri Debabrata Rout, Head Power Distribution, India Operations, Enzen Global, stated that Pradhan Mantri Sahaj Bijli Har Ghar Yojana – SUBHAGYA was launched by the Prime Minister on 25th September, 2017. The aim of this scheme is to provide energy access to all by last mile connectivity and electricity connection to all the remaining un-electrified houses in rural and urban areas to achieve universal household electrification in the country. He touched upon the challenges to implement the Saubhagya Scheme.

Shri Shakeel Ahmed, IAS, stated that we have to provide power to improve our economy. 100% households' electrification is expected to be achieved by 31st December, 2018. SWOT analysis of Saubhagya Scheme is being done by the Government of India.

Shri Amit Gupta, Director, Legal & Corporate Affairs, Vikram Solar, stated that 1,50,000 houses are being electrified daily. By 11th October, 2018, 20 million households had been electrified. He also touched upon the need for Renewable energy integration with the grid and mini grids based on solar system.

The Plenary Session - II was on National Grid & RE Integration: Its Status and Perspectives.

Shri Pankaj Batra, Former Chairman, CEA, stated that we have to reduce 30% carbon emissions from 2008 level. Various measures are being taken in this direction by all stakeholders.

Ms Seema Gupta, Director, Operations, PGCIL Power Grid Corporation of India, stated that Renewable energy provides clean energy and does not have green house emissions. Renewable energy accounts for 12% of the total world capacity. China is the leader in the RE sector with 38% in solar sector and 10% in the wind sector. We have to reduce the carbon emissions by 35% by 2030. She talked about the need for robust transmission system, accurate forecasting and energy storage. Our aim should be "one nation one grid".

Shri Pradeep Parera, Principal Energy Specialist, Asian Development Bank, stated that we should invest in transmission sector and it should be linked to RE integration. We are investing more in distribution sector. Asian Development Bank and NITI Aayog have organised a number of workshops in Renewable energy integration. He also talked about the energy storage.

Mr. Reji Pillai, President, India Smart Grid Forum, stated that the world is looking at us in Renewable Energy area. China and India are working in Renewable Energy sector. All the states have net-metering policies in the RE sector. Roof top solar power and

electric vehicles can play a vital role in Renewable energy integration. He also talked about “one sun one earth” and one grid.

Mr. Markus Wypior, Deputy Director GIZ, spoke about the status of Renewable Energy integration in Germany. In Energy area, Germany aims to have a share of 40-45% by 2025 through Renewables. Germany is a huge promoter of Renewables.

The Plenary Sessions III, IV and V were on Building a Gas Economy: Gas Trading Hub in India, Clean & Green Coal and State Power Utilities respectively. A number of dignitaries shared their perspectives in the above areas.

The Summit was attended by about 200 delegates from various organisations and media. Some members of the Executive Committee of IIM Delhi Chapter also attended the Summit.

- Report from IIM Delhi Chapter

COMET 2018

The Indian Institute of Metals, Bhilai Chapter in association with SAIL, Bhilai Steel Plant, organized the two days International Conference on Metallurgy (COMET): Ushering Industry 4.0 on November 26th & 27th, 2018 in Bhilai.

The conference got off to a rousing start in Bhilai Niwas on November 26, 2018 with representatives of leading manufacturers, technology suppliers, scientists and academicians in attendance. During the welcome address, ED(Works) Bhilai Steel Plant and Chairman, COMET, welcomed the distinguished guests and delegates from different organization and said that this International Conference, in addition to giving new direction to the metallurgical industry will prepare us for entering into the 4th industrial revolution. He pointed out that Industry 4.0 is designed to change the whole equation of manufacturing by providing greater agility without sacrificing the aspects of quality cost and safety. He was confident that this is going to help our industries to improve their efficiencies and revenues beyond imagination. He also emphasised that implementation of Industry 4.0 in our sector will also have challenges like security issues, maintaining integrity of manufacturing processes, maintaining required reliability & stability for machine to machine communication, lack of regulations and standards and fear of loss of jobs due to automation. Inaugural speech of ED (W) was followed with release of Souvenir.

CEO, Bhilai Steel plant, Shri Arun Kumar Rath, in his inspiring inaugural speech, expressed that human power starts growing and performing when they face challenges. He pointed out that only human being could survive better of all the species because they have created language, communicated with each other and collaborated. He narrated how the industrial revolution 1.0 started with the invention of steam engine which was followed by the second industrial revolution by the development of electricity resulting in mass production. CEO further explained that industrial revolution 3.0 was through computerisation and automation where human intelligence had been programmed into machine. He defined 4.0 industrialisation, which is the theme of COMET 2018, as imbibing intelligence into the machines. In this context, CEO expressed that he has full confidence on the Bhilai steel plant populace and they would definitely raise the present status to much higher level by the challenges being faced, with their capabilities, skill and commitment.

The inaugural function ended with vote of thanks by Shri K. Das GM I/c (M&U) and Convener COMET 2018.

Brief on COMET programmes and participants

During the conference, 300 delegates representing 45 organisations from six different countries have converged in Bhilai for COMET 2018. Total 81 technical papers were presented during the conference. The business part of this conference was conducted in 5 sessions at 2 different locations over one and half days. Technical sessions started with Plenary Session which had 4 presentations by eminent persons.

Plenary Session

The inaugural session of COMET-2018 was followed by plenary session wherein 4 plenary talks were delivered.

The first plenary talk was delivered by Shri Ravinder Gujjar, Business Director, DuPont India. He deliberated on DuPont’s perspective on Industry 4.0 and the experiences and learnings derived. He emphasised that industry is progressing towards convergence of real world with the virtual world. In the constantly evolving digital technologies, starting from cloud computing, artificial intelligence, machine learning, block chains, poses a threat of hidden and unknown competitors. Under this circumstance, industry needs to make use of technologies for improvement in manufacturing processes, management system, people’s management, customer interaction etc. He also presented the concept of process maturity viz-a-viz digital maturity and emphasised that it has to move in synchronisation with each other.

The second plenary talk was delivered by Prof. Rajat Moona, Director, IIT, Bhilai. His prime emphasis was on standardisation of digitalisation processes. He deliberated on how our country has successfully been using in recent times the digital technologies for citizen services and governance, creating digital identity and private space in cloud. He also emphasised on the challenges that are faced in standardisation of digital processes through citing an example of smart driving license which started in laboratory sometimes in 1996 and a standard was formulated and approved after 15 - 18 years later. Still, considering the benefits of standardisation, like inclusiveness, security and safety, research body, practitioners and regulators need to work in tandem.

body, practitioners and regulators need to work in tandem.
The third plenary talk was delivered by Mr. Akilur Rahman, Chief Technology Officer, ABB India. He presented several examples of how the industry has moved towards smart technologies. He gave the example of motor which is an electro-mechanical device, can also be turned to a smart motor by using sensors to record its behaviour during service and transferring these information to clouds and thereafter analytics be applied to save energy, downtime and life improvement. Similarly, a sub-station, with the use of optical fibre instead of Cu-wires for various communications can act as a smart sub-station. He also navigated through various ABB initiatives to serve industry better with the help of technologies like robotics, augmented realty, cloud computing.
The fourth plenary talk was delivered by Mr. K.K. Gaur, VP & Business Unit Head (IA), SMS India. He emphasised, at the first instance, as to why at all industry 4.0 is needed. He deliberated that the emerging needs on the part of business like no slippages in delivery, consistent quality of goods and supplies, scheduling of production planning dynamically based on the needs of small batches. With reference to steel industry, he emphasised that although level-I and level-II automation are in place for long in each individual unit of iron and steel production, there is need to integrate them in order to monitor and control of input and output qualities. He also emphasised on the appropriate models and simulators so that the quality of the product and services to be up to the mark.

Technical sessions 26th & 27 Nov 2018

This was followed by 2 technical sessions on the same day. Each of which was conducted in 3 halls simultaneously. During these sessions, 56 presentations were made including 3 from Sponsors. Thematically all these presentations were divided into 6 groups and the themes were "Material Optimisation & Smart Ironmaking'', ''Robotics & Artificial Intelligence'', ''Innovative Energy Models'', ''Effective Coke Making, By-products & Refractories'', ''Emerging technologies in Casting & Refractory'' & ''Strategic Steel Processing & Development''.
One technical session was held in 3 halls simultaneously on 27th morning and a total of 25 presentations were made out of which 3 were sponsors presentation. The themes were "Environment and process management', Capacity upgradation for industry 4.0 and "Nano structured material and Nano technology".
Apart from that the sponsors papers were received from MECON, NISP Nagarnar, CET, RDCIS, NSPCL, Andhra University, OP Jindal university, BSP, NIT Durgapur, Paulwurth, Tega Industries, TRL Krosaki Refractories Ltd., PrimeMetals, Vesuvius, IIEST Shibpur, NIT Raipur, Lechler India Pvt Ltd., CSIR Bhubaneswar, RGUKT AP IIT, DRDO, Calderys, JSW steel, IIT BHU, SGSSL, RAMON Tech, Calderys india, ISP Burnpur, DSP etc.

Manufacturer's presentation

One technical session was held exclusively for the main sponsors where 8 nos. of presentations were made. These were:

- Indian Oil Corporation
- Vesuvius India Ltd
- TRL Krosaki Refractories Ltd
- RHI Magnesita
- Paulwurth
- Ramon Science, China
- ACB Mining Pvt Ltd
- FOSBEL

Concluding function

The conference concluded on 27th November with sharing of knowledge on new and emerging technologies in manufacturing industry. Addressing the concluding ceremony, chief guest Shri A K Rath, Chief Executive Officer, Bhilai Steel Plant, said that the use of modern digital technology in today's era has revived all the industries. Today, a new Industrial revolution is being ushered in with adoption of smart technology.
Expressing his views, Shri P K Dash, Executive Director (Works), BSP said that technical papers presented were very illuminating; they will also play an important role in overall development of our industries.
Participants from a swathe of institutions were effusive in their praise for the way the Conference and its proceedings were organized.

- Report from IIM Bhilai Chapter

UpComing Events

International Seminar on "Prospects and Challenges in Metallurgical & Allied Industries with Special Emphasis on Quality, Safety and Environment"

The Indian Institute of Metals, Kolkata Chapter is going to organize an International Seminar on "Prospects and Challenges in Metallurgical & Allied Industries with Special Emphasis on Quality, Safety and Environment" on 22nd February, 2019 at hotel Floatel on ganges, Kolkata.
For intensive interaction with all stakeholders, the organizer (IIM) takes pleasure in inviting Delegates, Advertisers and Sponsors to participate in full strength the make the event a grand success.

Call For Papers

Individual and contributory papers are solicited from national and international organisations, individuals and agencies involved in Mining, Mineral Processing, Metals Manufacturing & Processing and associated areas.
Please send the technical papers/presentations (in soft copies) to the following:
Convener : <tapchak2014 @gmail.com> mob 9230029517

Registration Fees (excluding GST as applicable)

- Corporate / Industry / R&D Personnel: Rs 4000/- (Per Head)
- Foreign Delegate € 55/US$ 65 (Per Head)
- Faculty Members and Academicians: Rs 2000/- (Per Head)
- IIM Members (In Service, Self Sponsored): Rs 1500/- (Per Head)
- IIM Members (Retired from Services): Rs 700/- (Per Head)
- IIM Student Members/ Non-student members: Rs 300/500 (Per Head)

Address for Communication

Tapan K. Chakravarty, Convener <tapchak2014@gmail.com> mob 9230029517
Swapan K.Basu, Organising Secretary
<swapan20051@yahoo.co.in> mob 9830917506
The Indian Institute of Metals, Kolkata Chapter
Flat No. 06, 3rd Floor, Block - E 15, Rajdanga, Nabapally, Kolkata - 700 078
T: +91 33 2441 6428, M: +91 9830917506, E-mail: iim_kol@yahoo.co.in,
W: www.iim-kolkata.com

Symposium on "Critical Non-Ferrous Metals: Establishing the value chain"

The Indian Institute of Metals, Mumbai Chapter in association of Indian Institute of Technology, Bombay is pleased to announce and invite academics, researchers and industry professionals in the fields of extraction and downstream processing of metals and alloys of critical non-ferrous metals like Rare Earths, Titanium, Zirconium, Hafnium, Tungsten, Niobium, Tantalum, Lithium, Solar PV Si etc. for a two-day symposium during 11-12 April, 2019.
The Symposium will have presentations covering recent developments and future commercial prospects in mineral processing, metal extraction, alloy production, environmental impact and waste management. The Organizing Committee cordially invites you to participate in this important event being held in Mumbai for learning, sharing, and networking in this important sector of nonferrous metals and value added products.

About the Symposium

The Indian aerospace, defence and atomic energy sectors have made important strides in the past decades and are aiming to commercialise some of the technologies for civil use. Diminishing carbon based resources and environmental concerns have

brought renewable energy to the forefront. Most of these programmes critically depend on non-ferrous metals, alloys and and other value added products. Examples are: rare earth (RE) permanent magnets in renewable energy and e-mobility, RE's in Ni-MH batteries, tungsten heavy alloys in anti-tank kinetic energy ammunition, titanium alloys in aerospace structures and propulsion, zirconium alloy tubes in atomic energy, niobium alloys in aerospace propulsion systems, lithium ion batteries, and many non-ferrous metals as alloying elements or catalysts. These emerging developments have been disruptive, at times, and changed the demand patterns of several metals & alloys. Nonetheless, the current volumes consumed by the market are limited, reducing the commercial viability.

The proposed two-day symposium will dwell upon the current status of production, supply chain management and applications of critical nonferrous metals within the country in the context of the emerging markets in the world. It will also highlight the challenges & new opportunities for the Indian industries working in extraction, processing and applications of these materials. The symposium will have invited lectures by experts and specialists. The following themes will be covered:

- Emerging trends, including business prospects, for critical nonferrous metals, alloys and other value added products
- Advances in extractive metallurgy
- Key infrastructure developments and shortcomings
- Alloy development & physical metallurgy, design, manufacturing and applications
- Sustainability challenges – raw materials, energy, waste & effluent treatment
- Mineralogical, chemical and metallurgical characterization.

Organizing committee:

Chairman:
Prof Amol A Gokhale,
Vice President IIM and Chairman, Non-Ferrous Division
Vice Chairman:
Shri D Singh, IREL
Convener:
Dr Vilas Tathavadkar, Aditya Birla Science & Technology Co Pvt Ltd
Co-Convener:
Prof Sushil K Mishra, IIT Bombay and Dr Alok Awasthi, BARC

Registration Fee:
IIM members: Rs 4000
IIM non-members: Rs 6000
Students & researchers: Rs 1500

MEMBERS' NEWS

Dr. Sanak Mishra has taken charge as the President of the Indian National Academy of Engineering (INAE; inae.in) from 1st JANUARY, 2019. Like the Indian National Science Academy (INSA), the INAE is an autonomous body affiliated to the Department of Science & Technology (DST), Govt. of India. The INAE has built up a good interface with various Govt. departments and agencies and is frequently called upon to provide inputs into policy domains concerning engineering and technology.

Dr. Mishra's this accomplishment, is in addition to his engagement as Senior Advisor to MIDHANI (since separating from the Indian Steel Association) and as an Independent Director on the Board of Schaeffler India Limited, a unit of the European operations of the multinational Schaeffler Group (of Germany) which is the second largest global producer of industrial and automotive bearings. He is also continuing to serve as a member of the Board of the newly established Steel Research & Technology Mission of India (SRTMI).

Hearty CONGRATULATIONS from the IIM Metal News.

ADVERTISERS' INDEX

These are the top-10 global mining trends expected for 2018

10 years of trends

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	The commodity price rollercoaster	Securing local supply	International fuels the sector	The cost of doing business	Paying the price of bullish behaviour	Productivity hits new lows	The pursuit of operational excellence	Operational excellence remains central	The drivers of shareholder value	Digitization
2	Squeezed by high costs & lower prices	Commodity rollercoaster continues	Volatility is the new norm	Commodity price chaos	Managing demand uncertainty	Market imbalances wreak pricing havoc	Innovation is the new key to survival	Preparing for exponential change	Unlocking productivity improvement	Overcoming innovation barriers
3	Credit markets put expansion at risk	Success hinges on demand management	Securing a social license	Keeping profits from targeted taxes	Capital project deceleration	Exploring the innovation imperative	The new energy paradigm	China's painful transition	Operating in an ecosystem	The future of work
4	Chronic talent & equipment shortages	Sustainability: an integrated approach	New taxes, regulations and governments	Stakeholders demand for CSR	Preparing for the M&A storm	Find funding: Debt, deals & survival	Dwindling project pipelines	Adjusting to the new normal	The digital revolution	Resetting stakeholder relationships
5	Permits, politics & policy volatility	Cost of capital dampens growth	Invest strategically – a long-term plan	Labour pain: The precarious talent gap	Governments eye the mining prize	The project pipeline stutters	Implications of disappearing financing	The shifting global energy mix	Cyber security: Mapping the threat	Water
6	Quality assets getting harder to find	Rising risks to the mining industry	The war for talent: A lost generation	Capital project quandaries	Corruption: Held to a higher standard	Local community demands intensify	Survival of the juniors	Stakeholders: Changing the dialogue	A shared vision for the sector	The image of mining
7	Consolidation: An industry imperative	Extreme mining: The next frontier	In search of the elusive pot of gold	Non-traditional financing	A new level of responsible behaviour	Resource nationalism spreads	Seeking new skills from new talent	Surviving the capital crisis	Re-earning a social license to operate	Shareholder activism
8	Environmental concerns continue	A need to merge but desire is lacking	Climate change: Disclosing & adapting	Risk multiplies as companies diversify	The talent gap: skills shortage looms	Regulatory crackdown on corruption	The waves of geopolitical uncertainty	A taxing time for miners	Transforming the operating model	Board realignment
9	The cost and complexity of compliance	Government intervention takes a toll	Poor infrastructure hampers growth	Volatility is the new stability	Safety: Insights from analytics	Safety: Getting to zero fatalities	Balancing stakeholder interests	The M&A paradox	Creating healthy & inclusive workforces	Financing and shareholder value
10	In the dark: Electricity shortages	Infrastructure costs are on the rise	Exploring new revenue opportunities	Countries compete on tough regulations	Getting the most out of technologies	Talent gap widens into executive	Collaboration with the government	An expanded corporate view on wellness	Reporting: Adopting integration	Commodities of the future

Source: Deloitte

http://www.mining.com/top-10-global-mining-trends-expected-2018/

Which Metals Are the Heaviest ?
When you talk about how heavy a metal is, you are really talking about how dense it is. Density is a measurement of how tightly matter is packed together. When you look into the density of different metals, you may be surprised. You may think of lead as being very dense, but many other metals have a far greater density.
Osmium and **Iridium** are the densest metals in the world, but relative atomic mass is another way to measure "weight." The heaviest metals in terms of relative atomic mass are Plutonium and Uranium.

Density vs. Atomic Weight
When talking about heavy metals, you need to distinguish between density and atomic weight. The density of a material is mass per unit volume. Density is measured in kilograms per cubic meter (kg/m^3) or grams per cubic cm (g/cm^3). Density affects how different materials interact. For example, many types of metal sink in water because the metal has a higher density (i.e., it is more dense) than water.
On the other hand, atomic weight is the average mass of atoms of an element. A unit of atomic weight, which is dimensionless, is based on one-twelfth (0.0833) of the weight of a carbon-12 atom in its ground state. In other words, a carbon-12 atom is assigned 12 atomic mass units. Atomic weight is more commonly known as relative atomic mass to avoid confusion because atomic mass isn't exactly the same thing as atomic weight, and "weight" implies a force exerted in a gravitational field, measured in units of force such as newtons.

Most Dense Metals
Osmium and **Iridium** are the most dense metals. In other words, their atoms are packed together more tightly in solid form than other metals. With a density of 22.6 g/cm^3 and 22.4 g/cm^3 respectively, osmium and iridium are about twice as dense as lead, which has a density of 11.3 g/cm^3. Osmium and iridium were both discovered by English chemist Smithson Tennant in 1803. Osmium is rarely used in its pure form and mostly mixed with other dense metals like platinum to create very hard, strong surgical equipment. Iridium is mainly used as a hardening agent for platinum alloys for equipment that has to withstand high temperatures. Platinum measures a density of 21.45 g/cm^3. It does not mix easily with other elements and in its pure form is used in catalytic converters, laboratory equipment, dentistry equipment and jewellery.

Heaviest Metal by Relative Atomic Mass
The heaviest naturally occurring element is Plutonium (atomic number 94, relative atomic mass 244.0). Other heavy metals in terms of relative atomic mass are Uranium (atomic number 92, relative atomic mass 238.0289), radium (atomic number 88, relative atomic mass 226.0254) and Radon (atomic number 86, relative atomic mass 222.0). Oganesson (atomic number 118) is the heaviest element on the periodic table, but it is a synthetic element that can't be observed in nature. Lithium (atomic number 3, relative atomic mass 6.941) is the lightest metal in terms of relative atomic mass.

Heavy Metal Definition
The correct definition of a heavy metal actually has nothing to do with relative atomic mass or density. Any toxic metal may be called a heavy metal, including lead, mercury, arsenic, cadmium, cesium, chromium, selenium, silver, nickel, copper, aluminum, molybdenum, strontium, uranium, cobalt, zinc and manganese, all of which exist naturally on Earth.

Claire Gillespie
https://sciencing.com/metals-heaviest-8751708.htm

Facts about Metals

- The word 'metal' derives from the Greek word 'metallon,' which means to mine, excavate or extract from the ground.
- 75% of all the elements on the periodic table are metals. The metals are subdivided into separate groups, such as basic metals, transition metals, alkali metals, alkaline earth metals, rare earth, lanthanides, and actinides.
- The most common metal found in the Earth's crust is aluminum.
- Even though aluminium is abundant in the crust, the most abundant element in the entire Earth is iron, which makes up a large part of the Earth's core.
- Up until Medieval Times, there were only 7 known metals, which were called the Metals of Antiquity. The Metals of Antiquity and their approximate discovery dates are:
  1. Gold (6000 BC)
  2. Copper (9000 BC)
  3. Silver (4000 BC)
  4. Lead (6400 BC)
  5. Tin (3000 BC)
  6. Iron (1500 BC)
  7. Mercury (1500 BC)
- Many metals are heavy or dense, although some metals, such as lithium, are light enough to float on water!
- Alkali metals, such as lithium, sodium, potassium, and rubidium, are so reactive they will ignite and even explode if placed in water.
- Some radioactive metals either glow from internal heat or else release radiation that reacts and produces visible light. Examples of radioactive metals that glow include plutonium (red from heat), radon (yellow to orange to red), and actinium (blue).
- Noble metals, such as silver, gold, and platinum, resist oxidation and corrosion in moist air.
- Precious metals have significant economic importance. Most of the precious metals also are noble metals, since it's important for a currency to resist wear and tear. Examples of precious metals include gold and silver.

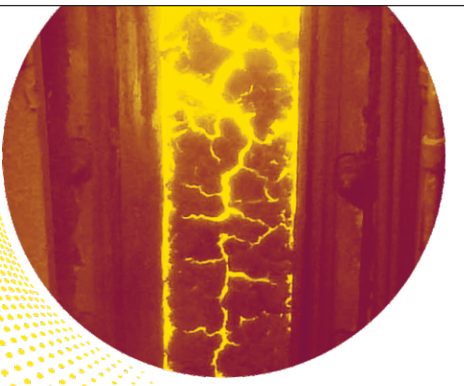
Tungsten is the metal with the highest melting point. Only carbon, a nonmetal, has a higher melting point of all the elements.

Anne Marie Helmenstine, Ph.D.
https://www.thoughtco.com/metal-facts-sheet-608443

10th Cokemaking Course

May 12 - 17, 2019

McMaster University,
Hamilton, Ontario, Canada



Cokemaking has evolved into a very efficient and sophisticated process. Cokemaking is one of the most important operations in the steel industry because it is the key to energy consumption in the plant and has a major influence on the operation of the blast furnace. Proper control and maintenance of the coke plant may offer solutions to many of the environmental problems associated with steel production.

The course will present "state-of-the-art" knowledge of the entire coke plant at a level that will be useful to producers, researchers and suppliers to the industry. While the focus of the course will be primarily on coke for blast furnaces, some consideration will be given to coke for other uses. The material presented and the structure of the course is continuously updated by a team of international experts.

Organizing Committee

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Stelco *(Chair)*

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Teck Coal Limited

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