REFORMS IN EDUCATIONAL PATTERN OF METALLURGICAL ENGINEERING

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The Beginning….

- Department of Geology, Mining and Metallurgy at the Banaras Hindu University in 1923
- Department of Metallurgy, Bengal Engineering College, Shibpur in 1939
- Department of Metallurgy University of Poona in 1939
- Department of Metallurgy, IISc Bangalore in 1945
- Department of Metallurgical Engineering, IIT Kharagpur, in 1956, followed shortly by IIT Bombay, IIT Kanpur, IIT Madras and by several Regional Engineering Colleges (Now called NITs)
The tilt was more towards extractive metallurgy with its necessary paraphernalia of Mineral Dressing, Fuels and Refractories, Metallurgical Assaying, and the distantly related subjects like Mineralogy and Economic Geology.

Foundry Metallurgy had always a place of pride in the curriculum, as the foundries provided ready jobs to a sizable number of graduate engineers. So was Heat Treatment of Metals.

Subjects of general engineering such as Strength of Materials, Engineering Mechanics, Fluid Mechanics, Machine Design, Electrical Technology, Basic Electronics, Engineering Drawing and Workshop Practice were always the precursors to metallurgical subjects; even surveying was included.
Development...

- With the passage of time, the metallurgical curriculum started giving emphasis on fundamentals, and courses like Metallurgical Thermodynamics, Metallurgical Kinetics, Transport Phenomena, Phase Transformations, Deformation Behaviour of Metals, X-ray and Electron Microscopy, Metal Physics, and Corrosion began to be taught as separate subjects.
The traditional approach towards metallurgy changed to materials science approach in the late sixties in some of the US universities.

The debate for the introduction of Materials Science and Engineering replacing metallurgy was on in India even in the early seventies.

The transformation was slow, but by the nineties most of the metallurgical engineering departments converted themselves to a compromise Department of Metallurgical and Materials Engineering with the introduction of a few core and elective subjects related to ceramics, polymers and electronic materials.
Curriculum for B.Tech. (Hons) Course at IIT Kharagpur

Core Subjects:

Curriculum for B.Tech. (Hons) Course at IIT Kharagpur

Elective Subjects: *(One to be chosen from each group)*

- **Elective 1:** Physics of Metals, Electronic Materials, Rate Phenomena in Metallurgical Processes, Genetic Algorithms in Engineering Process Modelling
- **Elective 2:** Powder Metallurgy, Joining of Metals, Casting and Solidification
- **Elective 3:** Advanced Phase Transformation, Furnace Technology, X-ray and Electron Microscopy
- **Elective 4:** Advanced Ferrous Metallurgy, Mechanical Working of Materials, Non-ferrous Metallurgy
- **Elective 5:** Fatigue, Creep and Fracture, Composite Materials, Ceramics for Engineering Applications
- **Elective 6:** Design and Selection of Materials, Surface Engineering, Metallurgical Failure Analysis, Polymer Technology
Curriculum for Dual Degree Course at IIT Kharagpur

Core Subjects:

- Common with B.Tech. up to the eighth semester
- Ninth and tenth semesters:
  Computer Applications in Metallurgical Processes, Diffusion in Metallurgical Processes, Corrosion and Environmental Degradation of Materials
Curriculum for Dual Degree Course at IIT Kharagpur

Elective Subjects:

- **Electives 4, 5 & 6**: Same as in B.Tech. (Hons) curriculum
The purpose of any professional course is to prepare the students to face the requirements and challenges of the profession that can be of diversified nature, viz.

1) Maintenance of production level of the industry, increase in production/cost effective production through innovation, and effective marketing of the produce,

2) Awareness of the increasingly important role being played by energy and environment in design and operation,

3) Innovations in materials and processes through research and development,

4) Involvement in manpower production for the profession, i.e. teaching.
ANALYSIS…

- The requirements vary depending on the type of industry in question.
- The UG curriculum has been deliberately kept broad-based so that a fresh graduate can fit in all these diversities.
- It has been tacitly assumed that all the fresh graduates of metallurgy will be employed only in the hard core metallurgical industries (including foundries) and in core engineering industries.
In the mid nineties, the job availability in these sectors was meager, and a majority of the fresh undergraduates had to remain satisfied with software jobs.

It is also true that higher emoluments and white-collar jobs allured some fresh graduates.

The defaulters sought refuse in M.Tech. studies, and again the opportunities for the M.Techs being not bright, the defaulters would enter Ph.D. programmes just to keep themselves engaged bringing about a dilution.
ANALYSIS…

- The situation is even precarious if we analyze the outcome of the introduction of ‘materials’ aspect in the metallurgical engineering curriculum.

- The polymer industry hardly employs any graduate of ‘Metallurgical and Materials Engineering’. They rather rely more upon the traditional chemistry graduates and M.Techs in Materials Science, who have basic degrees in science.

- The jobs related to electronic materials go to physics graduates or electronic engineers.

- In the ceramic industries, the opportunities for graduates of ‘Metallurgical and Materials Engineering’ are few.

- A few brilliant and motivated students have found this background useful for pursuing higher studies abroad.
REFORM...

*The reasons for Materials Engineering bias:*

- The switch over to materials science in the US in the sixties was intimately associated with the development of new electronic materials for the ever-increasing range of electronic goods and computers.
- The emergence of composite materials as a very important class of engineering materials which involve metal-ceramic and metal-polymer also necessitated this change.
- Another factor was the stricter pollution control rules in that country which led to the closure of many a smelting and foundry industry.
- Nevertheless, the unified approach towards the structure-property correlation of the apparently different materials was an exciting scientific exercise which easily attracted physical metallurgists all over the world, and India was no exception.
Impact of change over:

- The metamorphosis has, no doubt, helped the students to develop a broad-based approach to all materials of engineering interest, but has not helped in the area of jobs in the country.

- The dictum ‘what is good for the gander is not good for the goose’ was conveniently forgotten. By increasing the bias on materials engineering, the emphasis on extractive metallurgy has been diluted, although in India there remains a large potentiality for this sector.
Potentiality of the extractive metallurgy sector:

- The current day production of steel in the country is 35 million tons, and the target production in 2010 AD is three times this figure. Both conventional steel making as well as secondary steel making will have to be boosted.

- Apart from manpower requirement for the steel making operation, trained persons will be required for the production of quality refractories, upgrading and utilization of lean ores, and to maintain the downstream production line involving continuous casting, rolling and quality coating.

- Besides steel, there is big potentiality for the increase of production of aluminium and zinc.

- India has a huge reserve of titanium ores, and Indian Rare Earths Limited is currently engaged in enriching the ore for export. This situation must change. The metallurgical graduates of tomorrow should be employed to take the challenge of taking a lead in titanium production.
Suggestions:

- The suggestion is not to discard the ‘materials engineering’ stream, but to boost the ‘extractive metallurgy’ stream.
- The broad base of the curriculum should remain.
- An increase in the number and reshuffling of relevant electives in the area of extractive metallurgy and motivating the students to opt for them could be the immediate starting point.
- The provision of guided vocational trainings in the related industries would enhance such motivation.
- Our social goal of sustainability, which is driven by a complex interaction of energy and environment, should be addressed in the revised curriculum.
“It is always safe to assume, not that the old way is wrong, but that there may be a better way.”
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Thank You...