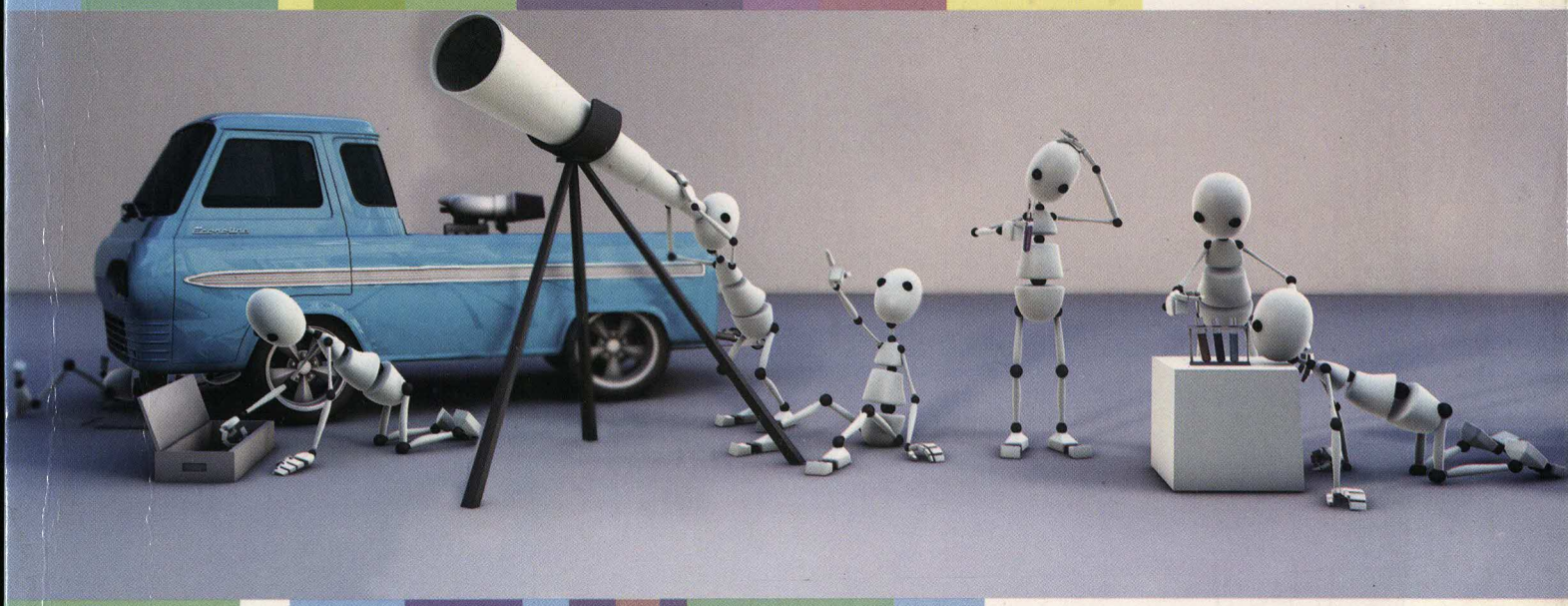
GOLDEN JUBILEE

TEACHING SCIENCE IN SHILLONG COLLEGE

1963- 2013



SHILLONG COLLEGE
विद्यया विन्दतेरमृतम्
SHILLONG
ESTD KNOWLEDGE IS IMMORTAL 1956

SOUVENIR

GOLDEN JUBILEE OF TEACHING SCIENCE IN SHILLONG COLLEGE
KNOWLEDGE IS IMMORTAL

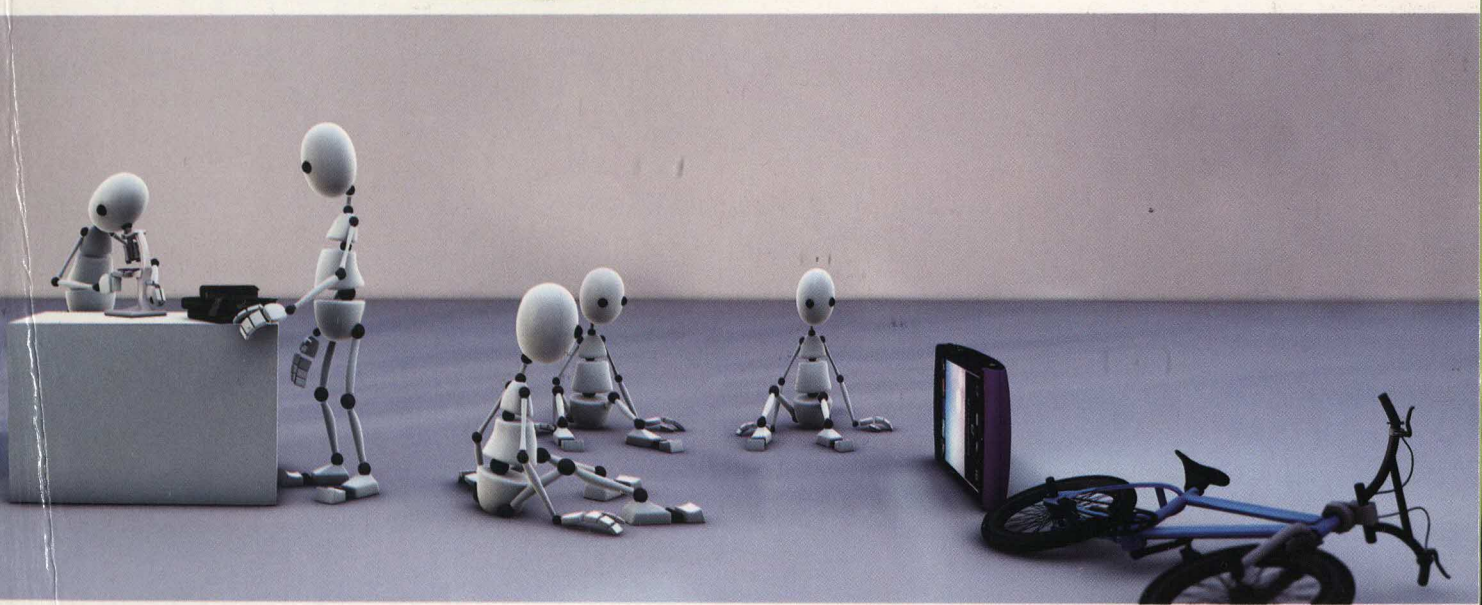
"EMPOWERING SOCIETY: SCIENCE-TECHNOLOGY-KNOWLEDGE"

ww.shillongcollege.ac.in

Find Out
Who
You
Really
Are
?

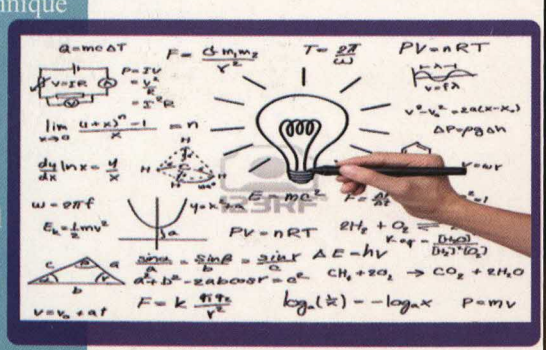
And what
Your
can really
do.....
Discover
Yourself

Have you learned it all
Have you discovered it all
Science is full of possibilities
Question Yourself
Have you ?



Science is all about experimenting and exeriencing..mix it, melt it , break it, fix it and shake it.....

We bring You all
The basic idea of science
With the advance
teaching teachnique
Discover all
the
possibilities and
and explore
something new and
learn something
new.....



OUR PRINCIPALS

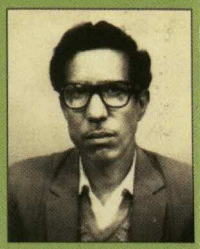
FORMER TEACHERS IN SCIENCE STREAM


Anjali Dutta

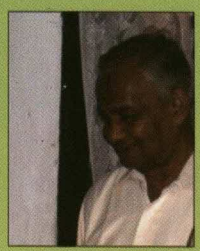

BC Goswami


Bipul S. Purkayastha


Dr. A A Ahmed


K K Choudhury

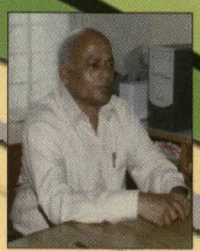

Kamalaksha Dutta


Rajat Kr. Das

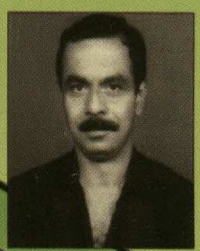

Ramananda Bhattacharjee


Rekha Devi

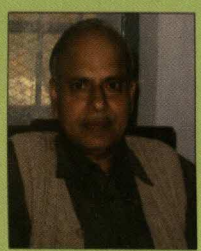

P. Deb


S K Gupta


Udayan Ghosh


H Dhar


Ranjit Dutta


Shri Durbadal Mukherjee


Suparna Choudhury


Surva Dhar


S N Dutta


UC Kakati


Shri TJ Kharbhih


Roma Sarkar

SHILLONG COLLEGE

SHILLONG
(ESTD. 1956)

(REASSESSED AND RE-ACCREDITED IN 2010 BY NAAC WITH CGPA: 2.92)

GOLDEN JUBILLEE OF TEACHING SCIENCE IN
SHILLONG COLLEGE
1963-2013

EMPOWERING SOCIETY
SCIENCE-TECHNOLOGY-KNOWLEDGE

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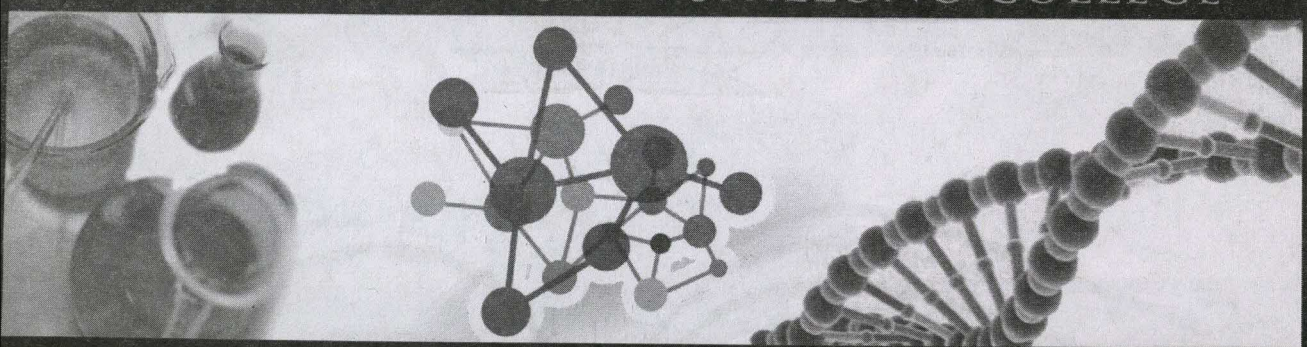
SHILLONG COLLEGE
BOYCE ROAD | SHILLONG 793003 | MEGHALAYA

GOLDEN JUBILEE
of
TEACHING SCIENCE IN SHILLONG COLLEGE



SHILLONG COLLEGE
BOYCE ROAD, SHILLONG-793003

Dr. Mukul Sangma
Chief Minister
MEGHALAYA

सत्यमेव जयते

MESSAGE

Since its inception, Shillong College has done a commendable job in spreading quality education to the students of Meghalaya and its neighbouring states and in this endeavour, it is heartening to know that the College has reached yet another milestone with Science Department achieving 50 years of dedicated service.

It gives me immense pleasure to know that to commemorate this historic milestone, the College has left no stone unturned to celebrate this grand occasion befittingly and that the commemorative souvenir is being published to mark the same.

On this Golden Jubilee celebration, I extend my heartfelt congratulations to the Science Department and the College as a whole and I am confident that in the years to come, the Shillong College will continue with its dedicated service towards the betterment of the society and the State as a whole.

I wish the Celebration a grand success.

(Dr. Mukul Sangma)

Office : 0364-2224282
PABX : 2200
Fax : 0364-2227913
(R) 2522752

Prof. R.C.Laloo M.Sc, Ph.D.
Deputy Chief Minister
Government of Meghalaya
Shillong 793001.

सत्यमेव जयते

MESSAGE

It gives me immense pleasure to know that the Shillong College is going to celebrate its Golden Jubilee and a Souvenir will be brought out to commemorate this special occasion.

The College has been serving in providing quality education to the student of this particular region. This particular College had rendered valuable services in educating the young adults in different streams of their studies. The presence of dedicated and hard-working staff and administrators, the reputation of the College has gained prominence in this region. May the College continue to render its services and marches forward towards further excellence in the field of education.

I convey my greetings to the Principal, staff, administrators and the students of this College and wish them grand success in their endeavours.

(Prof. R.C. Laloo)

Office: Room No.413, Yojana Bhavan,
Tel. No: 03642224576, PABX : 2644, Mobile: 9862088281
e-mail : rclaloo4@yahoo.com

Shri H.D.R. Lyngdoh
Minister,
Transport, General Adminstration Department,
District Council Affairs, Cooperation
Meghalaya, Shillong-793001
(INDIA)

सत्यमेव जयते

MESSAGE

I am happy to know that the Golden Jubilee (Teaching Science) Celebration Committee, Shillong College, Boyce Road, Shillong and its management is going to celebrate the GOLDEN JUBILEE OF TEACHING SCIENCE in Shillong College sometime on 23rd July, 2013 in a very special and benefiting manner.

In this new era of Science and Technology inculcating of scientific ideas and its significance to each and every student is a must. The vastness of scientific ideas has no limits especially in the present day context of new inventions.

With this aim in view I would like to urge all the students especially the science students to devote most of their time and energy on this particular subject and bring out a new idea/change in the days ahead.

With these few words once again I wish the "GOLDEN JUBILEE OF TEACHING SCIENCE of Shillong College, the Convener, Souvenir Sub-Committee and all the active members of the College a grand success.

Dated Shillong,
The 4th July, 2013.

(H.D.R. LYNGDOH)

Shri A.L.Hek,
Minister,
Health & FW, IPR, IT, etc.
Meghalaya, Shillong.

सत्यमेव जयते

MESSAGE

I am indeed delighted to know at last that the tireless efforts of the teachers and the College have finally borne fruits the promulgation of education to the students. The Institution had produced the reputed Scientists, teachers, social activists and so on and so forth.

I would therefore, hope that this commemoration of the "Golden Jubilee of Teaching Science in Shillong College" and a week long programme would surely boost the academic and co-curricular activities for the welfare of the students and community of the society.

I congratulate for your valuable times and I wish that these will not only continue to remain annals of the history of the College, but help the researchers as well.

(A.L.HEK)

Office: Room No.411, Yojana Bhavan, Meghalaya Secretariat, Shillong-1
Phone : 2224561 (Office) 9436103383 (Mobile)

E.R. Solomon
Addl Dy. Comptroller & Auditor General

सत्यमेव जयते

OFFICE OF THE COMPTROLLER &
AUDITOR GENERAL OF INDIA
10, BAHADUR SHAH ZAFAR MARG.
NEW DELHI-110002

MESSAGE

Dear Dr. Ramsiej

I have received your letter dated 22.5.2013 and am glad to know that the College will be celebrating the Golden Jubilee of Teaching Science in the College from the 23rd of July ,2013. It has been more than 34 years now since I left the college, and during my last visit to Shillong I have seen the immense transformations undertaken by the college authorities for raising the standards of education for our youth.

In this age of rapid developments in technology and where vertical and horizontal mobilities are the requirements of the day, I suggest that the college authorities plan to develop courses for skill development as part of the curricula. Funds for skill development are available from most Ministries of the Govt. of India and this channel could be explored so that the college does not only function as an academic institution but facilitates the generation of a trained workforce.

I have very fond memories of my association with the College though even for a short time.

I wish the week-long celebrations of the College all success.

Yours sincerely

18/6/2013

E.R. Solomon

SHILLONG COLLEGE

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(ESTD. 1956)

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1963-2013

EMPOWERING SOCIETY
SCIENCE-TECHNOLOGY-KNOWLEDGE

SHILLONG COLLEGE
BOYCE ROAD | SHILLONG 793003 | MEGHALAYA

With Compliments from

DR. K. DHIRENDRO RAMSIEJ
PRINCIPAL
SHILLONG COLLEGE

AND

ALL THE FACULTY MEMBERS OF SCIENCE STREAM
OF SHILLONG COLLEGE

Published by:

Principal

Shillong College,

Shillong 793003

Phone: 0364-2224903, Fax: 0364-2502143

e-mail: shillcoll@yahoo.co.in

www.shillongcollege.ac.in

Incharge;

Publications and Souvenir

Dr. M. N. Bhattacharjee

manabendra_bhattacharjee@yahoo.co.in

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FOREWORD

Dr. K. D. Ramsiej

As the domain of higher education system in the country gets expanded in absolute numbers with everyday developments, we need to strengthen the public higher education system in order to fortify the national intelligence, to increase contacts with scientific and intellectual community of the world, and to enhance capabilities and upgrade knowledge for further developments. Various policy decisions taken need to be implemented in true spirit to be able to improve the quality of life and services rendered to mankind, raise the percentage of enrolment in education and ensure quality and social justice. This can be assured with a strong foundation of public interest in mind and action to protect public services like health and education from predatory elements that preach the ideology of the market place as the solution to every issue.

Shillong College is an institution, established in 1956, that was raised by the benevolent actions of selfless service minded visionaries, and therefore always stood for public interest in its activities and expansion, reorganization and restructuring. With humble beginning on 15th August, 1956, with arts and commerce stream, the founders did not look back and took initiatives for expansion and started classes in Science stream with first Pre-University classes from 23rd July, 1963. In subsequent years, B. Sc. (Pass) classes were started followed by honour scourses in various subjects during 1970s and 1980s in a phased manner. We too did not look back and in the era of rapid scientific growth and multifarious economic changes, started B. Sc. (Computer science), Bachelor of Computer Applications, B. Sc. (Microbiology), Statistics and some other since the beginning of twenty-first century. We are indebted to the founders of the college, the Presidents and members of the all Governing Bodies of the College, the donors, the teachers and staff who have toiled untiringly since the inception of the college. Through their sincere efforts and dedication the college which had started in a very humble way has become one of the biggest institutions. All of us take pride in these achievements and therefore celebrate the appropriate occasions to honour all the members of the Shillong College family of the past and present. The students' community and the society also are to be complemented profusely for standing behind all these efforts of the past and present in a steadfast manner and facing many adversities occasionally. We appreciate the patronage of the then Government of Assam, Gauhati University, the Government of Meghalaya, North Eastern Hill University, University Grants Commission,

North Eastern Council and various other governmental and non-governmental organizations who have given us all the guidance, help and necessary facilities in march toward growth and development for the service of students community and the society. The fundamental values which an academic institution like ours tries to impart include 'learning to be' and 'learning to live together'. 'Learning to be' addresses the question of development of the inner capacity of the individual which would prepare him to meet the social and political responsibilities. 'Learning to live together', on the other hand, would involve the creating of a harmonious life, transcending sectarian loyalties and differences. There is no education without values, but in all societies values are a mixed bag. They are so because of differing ideological needs but there are certain universal values which all societies cherish and disseminate. Education is an effective agency of this process in modern times when a network of communication is in place. Today when the Indian society is entering a new phase of global participation, a variety of tensions is likely to emerge. One among them is related to the place of traditional values in a fast changing social, cultural and intellectual climate. That they cannot be discarded is generally acknowledged. It is equally true that there is no place for revival. The solution is creative integration of the values of both for which higher education, as a sphere of critical interrogation, could the pave the way.

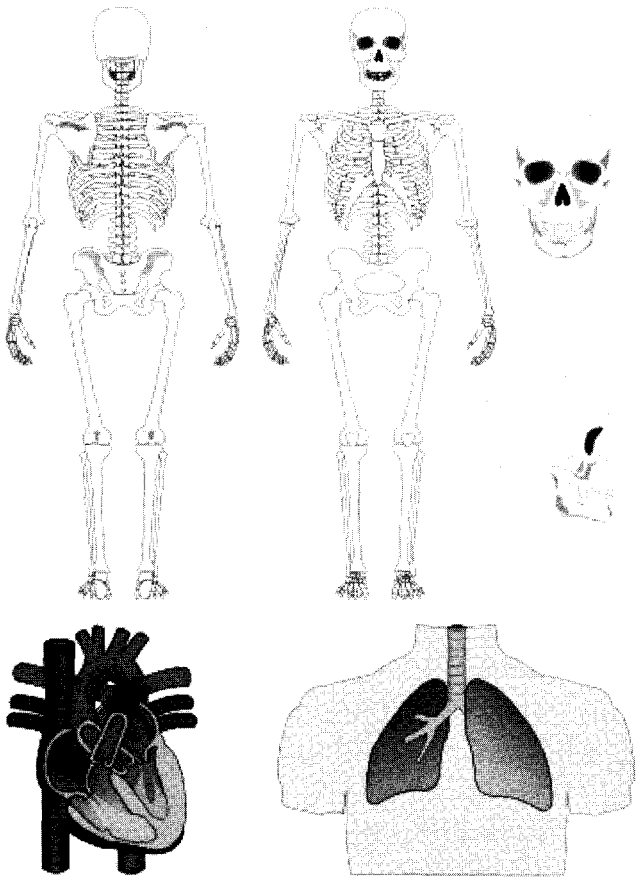
The concept that the values can be imparted to young generation through lecture demonstrations and syllabi-structure is not the 'cup of tea' for the Shillong College teaching community. We believe that the best way to do the same by practicing the values, through maintenance life style that corroborates to these values and doing such things that enhances these values. That is the scientific and thus we strive to add one more important value to the above, which is, 'inculcation of analytical mind and scientific temper' amongst all the students irrespective of the stream they belong to. A scientific rational thought process can only ensure our steady growth and development taking the civilization to better height and glory. The present celebration is another attempt in this direction, and I am sure, some success will be achieved in this direction.

The celebration of the Golden Jubilee of Teaching Science in Science College was inaugurated by Dr. M. M. Pallam Raju, the hon'ble Minister of Human Resource Development, Government of India, on 7th of June 2013, at the college campus. That was an unique historic occasions in the history of Shillong College and I congratulate the member of the Organising Committee of the Golden Jubilee Celebration for facilitating such an momentous occasion. Dr. R. C. Laloo, the hon'ble Deputy Chief Minister, Government of Meghalaya, Dr. M. Amparen Lyngdoh, the Hon'ble Minister of Urban Affairs, etc, Prof. A. N. Rai, the hon'ble Vice Chancellor of North Eastern Hill Universities, many other distinguished academician, administrators, social workers, important personalities from the society and host of others joined us in the inauguration of the events and

Inspired us to continue with work with zeal and vigour. The inaugural ceremony also saw the laying of foundation stone of the Sports Infrastructure Complex by the Hon'ble Union Minister which is funded by University Grants Commission. I express my gratitude to all of them for their presence and encouragent. My gratitude to our President of the Governing Body, Prof. K. S. Lyngdoh and all the members of the Governing Body, Dr. (Mrs.) M. P. R. Lyngdoh, our former Principal, Dr. Malay Dey, Vice Principal, Shri K. D. Roy, Vice Principal (Professional Courses), al the retired teachers, All the members of Teaching Faculty, the non-teaching Staff, Parents and Guardians, alumni and students for their support. I thank especially the members of the Faculty of Science subjects for taking this initiative and also giving best effort to make all the events of the celebration truly purposeful. My special thanks to Dr. M. N. Bhattacharjee and all the members of the Publication sub-committee for bringing out this Souvenir.

As a responsible citizens and education worker, we the members of the Shillong College Community have added responsibility to see that the College develops, progresses and grows from strength to strength in all streams in the years to come. Efforts towards Excellence for Wisdom and perfection continue, as we have carried the baton from our predecessors we shall pass on the same to our successors showing the characters of inclusive growth, commitment and dedication. As we take pride in our achievements, we also admit our shortcomings that accompany for reasons beyond our control and we assure each and every one that we endeavour to do ever better.

I wish each and everyone a grand celebration of the Golden Jubilee of Teaching Science in Shillong College, Shillong.



EDITOR'S NOTE

Dr. M. N. Bhattacharjee

With the initiatives from the faculty members in the Science stream, Shillong College fraternity has embarked on celebrating the Golden Jubilee of Teaching Science in the College and the main celebrations are scheduled to be organised from 23rd July to 30th July, 2013, while the formal inauguration of the celebration was accomplished through a colourful and momentous inaugural ceremony held on 7th June, 2013, at the college campus and graced by the honourable Union Minister of Human Resource Development Dr. M. M. Pallam Raju in the presence of Dr. R. C. Laloo, the honourable Minister of Higher and Technical Education, Government of Meghalaya, Prof. A. N. Rai, Vice Chancellor of North Eastern Hill University, Dr. M. Ampareen Lyngdoh, honourable Minister for Urban Affairs etc., Government of Meghalaya, many other dignitaries, academicians, students and teachers. It was the exemplary visionary of the then Principal (founder) Shri (late) S. C. Datta and the faculty members who were all from Arts and Commerce stream along with the far-sighted Governing Body members of early 1960s who took the historic decision to start the teaching science subjects in the college and opening of P. U. and degree courses in the science stream. While the formal inauguration of the science stream in the college was done on 22nd July, 1963, the teaching process started from 23rd July, 1963. Teaching in any stream arts or commerce or science is complimentary to each other and pioneers were committed that a scientific rational mind is prelude to substantive studies and knowledge-base in any branch which will produce better citizens discarding any form of superstitious and obscurantist beliefs, thus ensuring progress of the nation. Present generation of teachers and students desires to pay appropriate homage to the pioneers in celebrating this grand occasion.

Enrolment of students in science stream in the North Eastern region in +2 levels is much below the expected level and hovers around 8% to 9% in Meghalaya, in particular, in comparison to national average of about 37-40%. This is a dismal situation. Out of those who complete their +2 stage successfully, about 60% chose a career in technical, medical and allied fields leaving behind a handful of them to pursue their in science pure or amalgamated. As the future prospect of students in pure science stream, even with master degree or doctoral degree, is not commensurate with other professions, the students and parents get discouraged to take a career in this stream. The situation is even more distressing in this part of the country. Lack of adequate number of public-funded higher

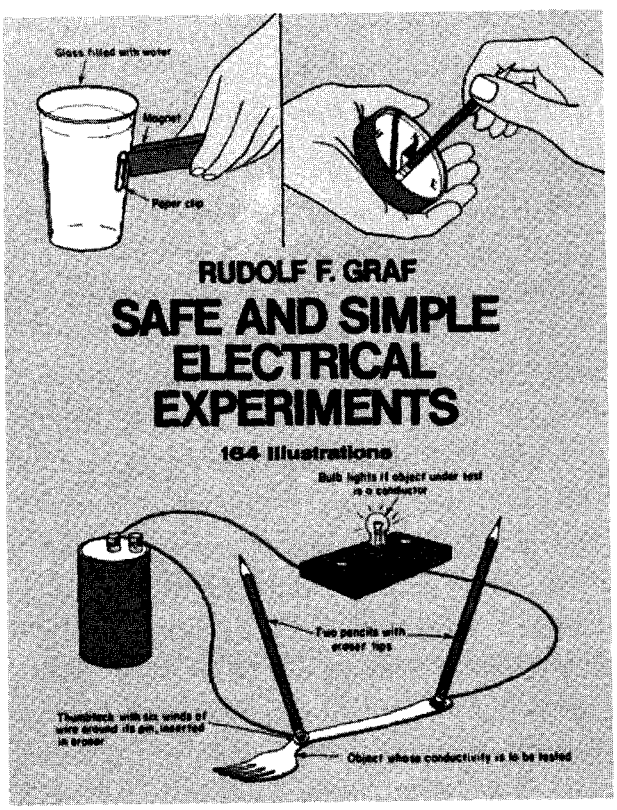
education and research institutes compared to the demographic changes and population explosion contribute to this dispiriting situation. Little positive efforts of the Government of India that are there in this direction are not being complemented by the State Governments. For many of the State Governments, investment in education, higher education in particular, is considered as wasteful expenditure leading to opening of the front to the private players with profiteering motive. PPP mode (private-public-partnership or public-private partnership!!!) is another retrograde step in this direction which, however, is very dear to some of political bigwigs and bureaucrats. Major contribution for the development of society and humanity need to come from government in a vibrant democracy with public-funded education system being the life line and private parties may be only facilitator provided they have philanthropic approach.

A career other than science is also equally lucrative and rewarding. But what is important in each and every career is a scientific and rational approach. A social scientist also looks at every incident and development with an analytical mind and derives conclusion with inculcation of scientific and systematic approach. Science should not be a mere career but a way of life. Emotional and idealistic approach often fails to provide results that are beneficial to human kind and progress of the society. This scientific approach leads to brilliance and thinking out-of-the-box. We still have a system that would try to fit a genius or brilliant into a procrustean bed of conformity. Brilliance would flourish in a system that does not put constraints and adversities on learners. As Bertrand Russell puts in his book, "The Conquest of Happiness", "There is a comfortable doctrine that genius will always make its way.....It is like the theory that murder will out. Obviously, all the murders we know of have been discovered, but who knows how many of there may be which have never been heard of? In like manner, all the men of genius that we have heard of have triumphed over adverse circumstance, but that is no reason for supposing that there were not innumerable other, who succumbed in youth".

A classic example may be cited on how this scientific approach changes life and thinking of a person towards society. Celebrated biological and genetic scientist, who was also a great humanitarian, Shri J. B. S. Haldane (1892-1964), who adopted India as his home leaving his native place in England was suffering from chronic stomach ailments and gastritis since the age of 15 for which he needed to take Magnesia regularly. But, as he was interested socio-economic development in addition to his scientific quest, he came across many literatures on dialectical materialism, Marxian philosophy and others. This resulted in a phenomenal change in his life and in his own words, ".....for about 15 years until I read Lenin and other writers who showed mewhat was wrong with our Society and how to cure it. Since then I have needed no magnesia".

As an editor of this publication, I feel honoured to have received learned and informative articles from Dr. S. Ganesan from Bhabha Atomic Research Centre, Prof. M. Bhattacharjee from IIT, Kharagpur, Prof. K. P. Sarma from Tezpur University, Tezpur, Prof. (Mrs.) B. Jyrwa from Department of Physics, North Eastern Hill University, Dr. K. K. Bhattacharjee, former Principal of College of Teacher Education, Tura and many former teachers of the college along with the serving teachers in addition to a few from past student. These articles not only provide various aspects of some recent scientific developments but also general approach to study science. We are indebted to Dr. M. M. Pallam Raju, the Honourble Union Minister for Human Resource Development for having inaugurated the Celebration. We acknowledge the brilliant performances of our students in different university/board examinations and hope that the present and future students will do much better and lift the flag of Shillong College higher and higher.

I acknowledge with gratitude the inspiration and cooperation received from Dr. K. D. Ramsiej, Principal of our College, Dr. Malay Dey, Vice Principal, and Shri K. D. Roy, Vice Principal (Professional Courses). All the members of the Organising Committee of the Golden Jubilee Celebration, all the members of the different sub-committees, all the members of the Faculty of the College especially of the science stream, the non-teaching staff and the members of Publication sub-committee deserve special mention for their endeavours and cooperation at every stage. In the present age, the fund management for a grand event like Golden Jubilee Celebration with such elaborate programme is a huge responsibility, and I propose a hearty vote-of-thanks to all the government and non-governmental agencies, commercial establishments, individuals, our ex-students and well wishers who have been spontaneous in extending their helping hands in the form providing display advertisement slots in the Souvenir and sponsorship of the other programme.



MOTTO OF THE COLLEGE

- "Knowledge Is Immortal"

VISION OF THE COLLEGE

- We envision Shillong College as a Centre of Excellence for Wisdom, a beacon of hope, a model embodiment of the ideal upon which our Great Nation has been built.

MISSION OF THE COLLEGE

- To endeavour to provide to all sections of society, quality yet affordable education, and create a knowledge-based society where avenues of success are readily available to all sections of the society, both urban and rural.

- To provide the right atmosphere that will facilitate the tapping, honing and refinement of latent potential talent and skill through appropriate academic, extra- and co-curricular activities, promoting the pursuit of excellence thereof and leading to integrated personality development.

- To remain socially committed, with special impetus on catering to the needs of the socially, economically and educationally disadvantaged groups, and through academic excellence, confidence building and character development to elevate them to a level of excellence. Thus, providing them with a fair chance of success and better future.

- To be attuned to the emerging needs of the young generations in a world of constant flux and to inculcate knowledge and need-based work skills so that the products of our College possess a competitive edge in the job market and find themselves prepared for gainful employment.

- To constantly update, equip, improve and evolve ourselves in all aspects in order to become more proficient and efficient in fulfilling our commitments to the students and the society at large to the best of our ability.

- To not only help our students become job-proficient but to sensitise, encourage and promote moral, secular, scientific and nation-building virtues in the backdrop of varied and complex multiplicities that weave the beautiful pattern of our country so that the students respect, protect, nurture and value the rich composite culture of the country, INDIA.

ABOUT THE COLLEGE

Realising the need for more colleges to meet the growing demands of higher education, some well-meaning, selfless and benevolent personalities of Shillong congregated in 1950 and formulated a scheme for starting a public college. A Steering Committee was formed with Late Rohini Kr. Choudhury as Chairman, Dr. P. K. Gupta and Prof. D. P. Chakraborty as Joint Secretaries. Other prominent members in the Committee included: Shri A. S. Khongphai, Shri A. C. Roy, Shri K. N. Dutta, Shri A. B. Choudhury, Shri K. R. Bhattacharjee and Shri P. C. Mazumdar. Preparations went ahead to start the classes from 1951 but due to some unavoidable reasons the plan could not be materialised at that point time.

However, efforts towards this noble cause continued. A public meeting was held at Bangiya Sahitya Parishad, Jail Road in May 1956 at the initiative of some enthusiastic academic-minded persons,

particularly Shri Satyen Kr. Kar and Shri Subhas Chatterjee of Lady Keane College and Shri Rajendra Nath Choudhury (Dadu) which gave a final shape to the plan and constituted First Managing Committee (Provisional) of the College with Shri Benode Behari Ghosh as President.

Finally, inauguration of Shillong College took place on August 15, 1956 and the college started functioning at Jail Road Boys' High School, Jail Road, Shillong with I.A. and I. Com. Classes beginning from 16th August, 1956 only in the morning session. Shri Sudhindra Chandra Dutta, a lecturer in the department of Mathematics, St. Anthony's College became founder Principal of the College. Since 1957, the college opened B. A. And B. Com. Classes both in Day and morning session.

As the college gained public support and patronage, it was able to procure a plot of land - the present campus (i.e. Boyce Road, Laitumkhrah, Shillong) mainly through sincere efforts of some great personalities of the town, particularly Late Shri Maham Singh. and started its classes in the present campus in late fifties. The land was procured during last part of 1950s and the foundation stone of the College campus at the new site at Boyce Road was laid by Shri B. P. Chaliha, the then Chief Minister of Assam, on 11th May, 1960. Thus the College, on having a campus of its own, began its most significant journey ahead towards growth and development. Since then all its academic and administrative activities are being discharged from the present permanent campus at Boyce Road, Laitumkhrah, Shillong in 1962. This particular development inspired the managing committee and the teachers to look further ahead and to start Science Stream in the College at the earliest. Thoughts and actions got coordinated intimately and the College directed all its efforts to start the Science stream from the very next year.

There was no looking back and the Science stream was started in the College with Pre-University Science course commencing from 23rd July 1963, with formal inauguration on 22nd July, 1963, and in the following year the B.Sc. Pass course was in place. This followed the inspection of the College and its laboratories by Dr. H. J. Taylor, Vice Chancellor of Gauhati University on 24th April, 1964, and thereby getting the approval of Science Section.

The journey of the college on the whole reached the 25th milestone in the year 1981 and the 50th milestone in the year 2006. The college celebrated in a grand way the Silver Jubilee of its establishment in 1988 and then the Golden Jubilee during 2005-06 with a year-long programme.

The college has earned several laurels in academic as well as co-curricular and extra-curricular areas over the years. It has been contributing significantly towards overall education scenario of the State as well as the region. It will continue to do so with the blessings and good wishes received from one and all.

ABOUT SCIENCE STREAM

On 23rd July, 1963, the College started the courses in science stream. Since then, the College has made steady progress in imparting higher education in all areas to the aspiring students with an affordable cost to all section of people. As time went on, the college took courage to start the honours courses in the Science subjects. The honours courses in Mathematics was opened in 1966 followed by the starting of B. Sc. Honours course in Botany and Zoology in the year 1978, Chemistry in 1986 and Physics in the year 1987. Lately in the year 2004-05 the Professional Courses like BCA, B. Sc. in Computer Science was started, and in the year 2007 B.Sc. in Microbiology was also started, being first of such courses in the region.

On 23rd July, 2013, the college will be completing 50 years of Teaching of Science in the institution. It is indeed another milestone in the history of the college. The Governing Body of the college and the members of teaching faculties, with one mind, felt that this Golden Jubilee of Teaching of Science in the College should be celebrated in a befitting manner and will include academic and other programmes. The celebrations will enable the college and its faculties to cope up with the changing educational scenario, developments in the science and technology, problems and challenges in teaching science particularly in terms of input and output and all allied frontier areas.

Responding to the initiatives of the teachers of Science Departments of the College, the College has drawn a week-long programme, Starting from 23rd July, 2013, to celebrate the Golden Jubilee of Teaching Science in Shillong College. The various programmes contemplated include:

1. An International Symposium on, "Attracting Best Talents in Science".
2. Students Science Seminar.
3. Students Contest like Quiz and Debate.
4. Science Exhibition by Scientifi departments (non-competitive).
5. Science Exhibition for students (competitive)
6. Alumni and Past teachers meet
7. Panel discussion
8. Cultural Programmes

The Organising Committee of the Golden Jubilee Celebrations, attempts to bring renowned Resource Persons from abroad, who will be delivering lectures / presentations / talks / speeches in the Symposium on "Attracting Best Talents in Science". This will be followed by the Students Seminar, Quiz, Debate, Science-Exhibition and then followed by the Alumni meet for past students and past teachers. A Panel Discussion is likely to be held where reputed educationist/teachers will be the panellists.

OUR PRINCIPALS

Sl No.	Name	Department	Period as Principal	At Present
1	Shri Sudhindra Chandra Datta	Mathematics	15-08-1956 to 08-1970	Expired on 20th June, 1986.
2	Shri Suddhabrata Bhattacharjee	History	01-09-1970 to 31-05-1973	Expired.
3	Shri Dhruba S. Rawat	Commerce	01-06-1973 to 31-10-1990	Expired on 27th January, 1993.
4	Shri Kanai Lal Choudhury	Economics	01-11-1990 to 31-03-1995	Expired on 16th February, 2003.
5	Shri Tapan Moitra	Economics	01-04-1995 to 31-10-1996	Expired on 1st July, 2006.
6	Dr. (Mrs.) Mary Pristilla Rina Lyngdoh	History	01-11-1996 to 31-12-2010	Presently residing in Laitumkhrah, Shillong.
7	Dr. Malay Dey	Zoology	01-01-2011 to 30-06-2011	Presently Vice Principal, Shillong College
8	Dr. K. Dhirendro Ramsiej	Philosophy	01-07-2011 till date	Our serving Principal

OUR VICE PRINCIPALS

The post of regular Vice-Principal of the College was created with effect from 1st November, 1996. Subsequently, another post of Vice-Principal to manage the profession courses was created with effect from 1st June, 2004.

Sl No.	Name	Department	Period as Vice Principal	At Present
1	Shri Tapan Moitra	Economics	01-11-1996 to 31-03-2000	Expired on 1st July, 2006
2	Shri Bankim Ch. Goswami	Mathematics	01-04-2000 to 28-02-2001	Retired, staying in Kolkata
3	Shri Umesh Ch. Kakati	Botany	01-03-2001 to 31-08-2001	Retired, staying in Guwahati
4	Shri Ranjit Kr. Datta	Physics	01-09-2001 to 31-08-2003	Retired, staying in Kolkata
5	Shri Nirmal Kr. Sarkar	English	01-09-2003 to 28-02-2005	Retired, staying in Shillong
6	Shri Durbadal Mukherjee	Physics	01-03-2005 to 31-03-2008	Retired, staying in Shillong
7	Smt. Rekha Debi	Zoology	01-04-2008 to 31-08-2008	Retired, staying in Shillong
7	Dr. Malay Dey	Zoology	01-09-2008 till date	- Serving
VICE PRINCIPAL (Professional Courses)				
1	Dr. Sudhir K. Gupta	Chemistry	01-04-2004 to 31-07-2008	Retired, staying in Kolkata
2	Shri Kallol Dutta Roy	Commerce	01-08-2008 till date	- Serving

ORGANISING COMMITTEE

ADVISORS:

1. Prof. A. N Rai, Vice Chancellor, NEHU
2. Shri V. H. Pala, Union Minister of State for Minority Affairs & Water Resources.
3. Dr. (Mrs.). K. S. Lyngdoh, President, Governing Body, Shillong College.
4. Dr.(Smt.) M.P.R. Lyngdoh, former Principal, Shillong College

Chairman: Dr. K. D. Ramsiej, Principal, Shillong College, Shillong

Convener: Smt. E. N. Dkhar, Head, Department of Physics.

Joint Conveners:

1. Shri D. Shadap, Head, Department of Mathematics
2. Dr. C. Masharing, Department of Chemistry
3. Shri S. Kharchandy, Department of Mathematics

Coordinator: Dr. Malay Dey, Vice Principal and Head, Department of Zoology

Members:

1. Shri Kallol Dutta Roy, Vice Principal, Professional Courses, Shillong College.
2. Shri Swapan Kr. Roy, Head, Department of Botany
3. Smt. Aiom Mitri, Head, Department of Computer Science
4. Shri Zoliansanga, Head, Department of Microbiology
5. Smt. M. B. Lynser, Department of Environment Education
6. Shri S. R. Nongkynrih, Head, Department of Commerce and Management
7. Shri Rudyson Rynjah, Head, Department of History
8. Shri T. S. Rajee, Head, Department of Khasi
9. Smt. P. Das,Head, Department of Statistics
10. Smt. D. N. Shabong, Department of Zoology
11. Dr. M. N. Bhattacharjee, Coordinator, IQAC

SUB-COMMITTEES:

I. **RECEPTION SUB-COMMITTEE**

Convener: Shri Spainborlang Kharchandy | **Joint Convener**: Shri M. W. Synrem

Members: Shri R. Rynjah, Shri S. R. Nongkynrih, Shri T. S. Rajee, Shri A. Dkhar, Smt. L. P. Shadap, Shri B. Syiem,

Smt. A. Mitri, Smt. A. Lyngdoh, Shri S. O. Lyngskor, Shri G. R. Rumnong, Shri S. Lato, Dr. B. P. Tirpathi, Smt. R. Gidon, Shri P. N. Jyrwa, Smt. L. D. Marak, Dr. S. Pandey, Dr. S. Sarma, Shri D. Syiem.

II. SEMINAR SUB-COMMITTEE

Conveners: Dr. (Smt.) D. L. Buam | **Joint Convener:** Dr. L. Jyrwa

Members: Dr. H. Diengdoh, Dr. C. Masharing, Dr. R. Dkhar, Smt. PPynhunshisha Kharkrang, Smt. I. Lyngdoh, Smt. R. Pyngrope, Shri Membanjopson Rynjah, Smt. V. R. Solomon, Smt. D. Kharshandy, Smt. R. Gidon, Smt. I. Sun, Smt. V.C.S. Dkhar, Shri B. Nongbri, Smt. A. Lyngdoh, Dr. S. Khongwir, Shri L. Khongiang, Shri A. Dkhar, Smt. D. Diengdoh, Smt. W. Lyatand, Dr. D. Bhowmik, Smt. P. Khonglah and Smt. B. Laloo.

III. EXHIBITION SUB-COMMITTEE

Conveners: Shri S. K. Roy Joint Convener:

Members: Shri Zoliansanga, Smt. Dalari Lyngdoh, Dr. P. Das, Shri Aiborlang Dkhar, Shri P. N. Jyrwa, Shri L. Khongiang, Shri T. Warjri, Smt. A. Mitri, Smt. A. B. Basaiwmoit, Dr. A. Nongbri, Smt. P. Khonglah, Smt. C. Dhar, Smt. M. Diengdoh, Smt. M. Lynser, Stm. I. G. Kharmawphalang, Smt. P. Kharkrang, Dr. E. Kharkongor, Shri S. Lato, Shri K. Umdor, Shri M. Rynjah, Shri D. Shadap, Shri S. Kharshandy, Smt. E. Kurkalang, Smt. R. Gidon, Dr. L. Jyrwa, Shri M. W. Synrem, Smt. D. N. Shabong.

IV. STUDENTS CONTEST SUB-COMMITTEE

Conveners: Smt. Aiom Mitri | Joint Convener: Shri G. R. Rumnong

Members: Shri P. N. Jyrwa, Shri D. Syiem, Shri M. W. Synrem, Dr. H. Diengdoh, Smt. R. Pyngrope, Smt. K. Lartang, Smt. D. N. Shabong, Smt. A. Marbaniang, Smt. B. Wanswet, Dr. A. Nongbri, Dr. (Smt.) D. Mawroh, Smt. M. Diengdoh, Shri L. M. Pariat, Smt. P. Khonglah, Dr. S. Pandey, Smt. W. Lytand, Smt. I. G. Kharmawphalang, Shri S. Kharrymba, Smt. B. Wanniang, Shri T. Warjri and Smt. B. Laloo.

V. ACCOMODATION AND TRANSPORT SUB-COMMITTEE

Convener: Shri Snarmon Lato | Joint Convener: Shri Kenneth Umdor

Members: Shri L. Pathaw, Shri L. M. Pariat, Shri M. W. Synrem, Shri H. Marwein, Shri Longkhraw Khongiang, Shri Barometer Nongbri, Shri M. Rynjah, Shri Teibor Warjri, Shri A. Khanduri, Dr. S. Sarma, Shri B. K. Saha, Shri Zoliansanga, Dr. A. Nongbri, Smt. A. B. Basaiwamoit.

VI. REFRESHMENT SUB-COMMITTEE

Conveners: Smt. D. N. Shabong | Joint Convener: Smt. D. Kharshandy

Members: Smt. S. R. J. Khongwar, Smt. W.C.K. Sohliya, Smt. J.Rivulet Gidon, Shri B. K. Saha, Shri P. Kipgen, Smt. N. Lytand, Smt. C. Dhar, Smt. S. Kharumnuid, Smt. J. Choudhury, Dr. J. Paul,

Smt. A. Diengdoh, Smt. K. Lartang, Smt. A. Marbaniang, Smt. B. Wanswett, Shri D. Syiem, Smt. O. Kharkongor, Shri D. Shadap, Smt. I. G. Kharmawphalang.

VII. PUBLICATION AND PUBLICITY SUB-COMMITTEE

Convener: Dr. M. N. Bhattacharjee | Joint Convener: Shri Aiborlang Dkhar

Members: Smt. A. Mitri, Smt. B. Wanniang, Smt. M. B. Lynser, Shri T. Warjri, Smt. Ibarihun Sun,

VIII. CULTURAL PROGRAMME SUB-COMMITTEE

Convener: Smt. I. S. Warjri | Joint Convener: Smt. M.V.T. Marwein

Members: Dr. (Smt.) J. Biswas, Smt. R. Pyngrope, Shri W. Lawai, Smt. M. Diengdoh, Shri M. Rynjah, Smt. W. Lytand, Shri P. N. Jyrwa, Smt. A. Diengdoh, Shri T. Tiewsoh, Shri G. R. Rumnong, Smt. V.C.S. Dkhar, Dr. (Smt.) D. Mawroh, Shri L. M. Pariat, Shri Zoliangsanga, Smt. P. Kharkrang.

IX. ALUMNAE SUB-COMMITTEE

Convener:Shri Dikes Shadap | Joint Convener: Smt. W.C.K. Sohliya

Members: Dr. Malay Dey, Dr. B. P. Tripathi, Shri Sojol Kharrymba, Shri Barometer Nongbri, Shri T. Tiewsoh.

DETAILED PROGRAMME

INAUGURATION 7TH JUNE, 2013

PROGRAMME FOR INAUGURAL FUNCTION OF GOLDEN JUBILEE CELEBRATION OF TEACHING SCIENCE IN SHILLONG COLLEGE, SHILLONG

10.00 a.m.-10.10 a.m.: Presentation of Bouquets and Mementoes to respective guests

10.10 a.m.-10.20 a.m.: Welcome Address by President of Governing Body, Shillong College

10.20 a.m.-10.25 a.m.: Welcome song by Students of Shillong College

10.25 a.m.-10.35 a.m.: Brief History of Teaching Science in Shillong College by Principal, Shillong College

10.35 a.m.-10.55 a.m.: Key Note address by Prof. A. N. Rai, Vice Chancellor, North Eastern Hill University

10.55 a.m.-11.05 a.m.: Address by Guest of Honour, Dr. R. C. Laloo, Hon'ble Minister for Higher and Technical Education, Government of Meghalaya

11.05 a.m.-11.15 a.m.: Short Cultural Programme by the Students of Shillong College

1.15 a.m.-11.20 a.m.: Introduction of Chief Guest by Dr. (Mrs.) M. P. R. Lyngdoh, former Principal, Shillong College

11.20 a.m.-11.40 a.m.: Inaugural Address by Chief Guest, Dr. M. M. Pallam Raju, Hon'ble Minister Of Human Resource Development, Government of India

11.40 a.m.-11.45 a.m.: Vote of Thanks by Smt. E. N. Dkhar, Convener, Golden Jubilee Celebrations

11.45 a.m.-11.55 a. m.: Laying of Foundation Stone of Sports Infrastructure Complex by Hon'ble Union HRD Minister, Dr. M. M. Pallam Raju

11.55 a.m. NATIONAL ANTHEM.

JUBILEE CELEBRATIONS

DAY ONE : 23RD JULY 2013, TUESDAY

10.30 A.M.: FLAGGING OFF THE CELEBRATION AND RELEASE OF SOUVENIR

12.30 p.m.: STUDENTS SCIENCE SEMINAR SCHOOL LEVEL FOR STUDENTS OF CLASS IX and X ONLY Topic: Science, Technology and Meghalaya: 40 years now, 40 years hence.

DAY TWO : 24TH JULY, 2013, WEDNESDAY

INTERNATIONAL SEMINAR ON "Attracting Best Talents in Basic Sciences Challenges and Prospects". Expected Resource Persons:

1. Prof. Md. Yousuf Ali Mollah, Dean, Faculty of Science, University of Dhaka, Bangladesh.
2. Prof. Amarjyoti Choudhury, Pro Vice Chancellor, Tezpur University, Tezpur, Assam.
3. Prof. M. Bhattacharjee, Department of Chemistry, Indian Institute of Technology, Kharagpur

12.30 p.m.: Technical Session I

02.30 p.m. to 4.30 p.m.: Technical Session II

DAY THREE: 25TH JULY, 2013, THURSDAY (Symposium continues....)

09.30 a.m.: Technical Session III

11.00 a.m.: Technical Session IV

1.30 p.m.: Technical Session V

4.00 p.m. SUMMING UP AND CONCLUDING FUNCTION

DAY FOUR: 26TH JULY, 2013, FRIDAY

SCIENCE EXHIBITION

SECTION ONE STUDENTS competitive

Group I Class IX and X only for Students in Science stream

Group II Class XII and XII only for Students in Science stream

SECTION TWO SCIENTIFIC ORGANISATION/DEPARTMENTS demonstrative

To be inaugurated by 10.00 am and continues up to 02.00 p.m. next day i.e. 27th July, 2013, Saturday.

DAY FIVE : 27TH JULY, 2013, SATURDAY

SCIENCE EXHIBITION CONTINUES

STUDENTS' PROGRAMME INTER COLLEGE DEBATE COMPETITION

10.00 A.M. (Undergraduate Level)

Topic: In the opinion of the House,

"CLONING: - A HUMAN DESIGN TO SAVE ENDANGERED SPECIES".

12.30 p.m. INTER-COLLEGE/SCHOOL QUIZ COMPETITION CLASS XI-XII

28TH JULY, 2013, SUNDAY - NO ACTIVITY

DAY SIX: 29TH JULY, 2013, MONDAY

ALUMNI, STUDENTS, TEACHERS (PAST & PRESENT) DAY

10.00 A.M. TO 11.00 A.M.

ALUMNI MEET AND RECOMMENDATIONS

11.30 A.M. TO 1.00 P.M.

A discussion on "LOOKING AHEAD; FUTURE COURSE OF ACTION TO BE TAKEN BY THE COLLEGE TOWARDS THE PROGRESS OF SCIENCE EDUCATION AT THE DEGREE LEVEL".

2.OO P.M. FELICITATIONS AND GENERAL OPEN HOUSE PROGRAMME OR PANEL DISCUSSION

DAY SEVEN, 30TH JULY, 2013, TUESDAY

VALEDICTORY FUNCTION AND CLOSING CEREMONY AT 11.00 A.M.

PRIZE DISTRIBUTION OF THE VARIOUS COMPETITIONS/CONTESTS.

02.00p.m.-04.00 p.m. Student Activities and Cultural Programme

SPEECH BY PRINCIPAL, DR. K. D. RAMSIEJ,

IN THE INAUGURAL FUNCTION ON THE HISTORY OF SHILLONG COLLEGE WITH REFERENCE TO SCIENCE STREAM

Respected Prof. K. S. Lyngdoh, Chairperson, Honourable Dr.M. M. Pallam Raju, Chief Guest, Prof. R. C. Laloo,Guest of Honour, Prof. A. N. Rai, Vice Chancellor, North Eastern Hill University, Dr.(Mrs.) M. P. R. Lyngdoh, Former Principal of the College, Smti. E. N. Dkhar, Convener, Organising Committee, Other distinguished Guests and Dignitaries, Principals , teaching and non-teaching Staff of different colleges and schools, Members of alumni, esteemed colleagues, members of press and electronic media, students, ladies and gentlemen:

I, deem it an honour and privilege to present a brief historical account of this premiere institution on the auspicious "Inaugural ceremony of celebration of 50 years of teaching science in the college", in your presence, more particularly before the Honourable Union Minister of Human Resource Development, Dr. M. M. Pallam Raju, Prof. R. C. Laloo, Dy. Chief Minister, Government .of Meghalaya and other distinguished Guests on and off the dais.

Post independence India, during 50s the Nation was going through a series of insufficiency and inadequacy. The country was reeling under extreme poverty, illiteracy, superstitions, food crisis, under qualified unemployable human resource and many other such deficiencies. It was then the need of the hour to find the ways and means and overcome the situation. Development of Human resource with adequate knowledge and expertise was of prime importance. The gravity of higher education and its role that ought to bring the desired change was widely appreciated nationally and a statutory body in the name of The University Grants Commission was established in the year 1956 by an act of the parliament. Since then the commission has been serving the nation as the regulatory body enhancing higher education all over the country.

Around the same time, here, in Shillong, though there were a few, so called elite colleges catering to the needs of the students of the region but as aspirants from all over the North Eastern Region of India used to converge here, it was impossible to accommodate all of them, resulting into a huge number of dropouts. These dropouts, despite having the urge and talent to acquire higher qualifications had no other options but to seek and accept employment available to them. Dissatisfaction and depression kept haunting them every now and then.

The problem was promptly identified and to redress the issue a few farsighted common but responsible and sensible citizen of the capital town started mobilizing the noble opinion of setting up an institution that would provide an opportunity to these dropouts and others. It was further under stood that not only the men but the women aspirants too be given the same right and things moved in the right direction : The 1st Co-Educational College of the town Shillong College, established on 15th of August,

the Independence Day of 1956. At this juncture, out of the many names, a few, that I would like to mention with a deep sense of respect and gratitude are: Shri Rohini Kr. Chaudhury, Dr. P. K. Gupta, Prof. D. P. Chakraborty, Shri A. S. Khongphai, Shri A. C. Roy, Shri K. N. Dutta, Shri A. B. Choudhury, Shri K. R. Bhattacherjee, Shri P. G. Mazumder, and Shri Binod Behari Ghosh, Shri Satyan Kar, Shri S.C Dutta and many others.

Shri Sudhindra Chandra Dutta, took over as the founder principal of the college and classes started on 16th August 1956 in Jail Road Boys' High School, Jail Road with a handful students in I.A and I.Com. Later, in 1958 B.A and B.Com courses were introduced. Since then the college has been growing from strength to strength combating series of hurdles along the journey. The College acquired its own campus in the year 1962, the foundation stone of which was laid by the then Chief Minister of Assam, Shri Bimola Prasad Chaliha on 11th May 1960. Today the college has 57th year of its glorious existence and has to its credit a large number of graduates in Arts, Science and Commerce, contributing towards over all development of the society.

Importance of Science education was realized during late 50s and early 60s and great emphasis was paid Nationwide towards its achievements. The Nation demanded a distinguished work force in place with scientific temperament and adequate knowledge to maneuver towards industrialization. Once again the college management was quick enough to respond to the call.The idea of introducing Science stream started growing during late 50s and in the year 1963, more precisely on 23rd of July 1963, Intermediate Science (I. Sc.) classes commenced with a few students in an inadequately furnished infra- structure. Meanwhile preparations were made for inviting the then Vice-Chancellor of Gauhati University. Shri H. J. Taylor visited the college for on the spot inspection and accorded approval of the Science Stream on 24th April 1964. B. Sc Pass course commenced in the same year and the first batch of Science students graduated in the year 1967. Honours course in Mathematics began in the year 1966.

Science stream was brought under Deficit Grant in Aid by the Government of Meghalaya in the year 1975 with effect from 1st April. Honours courses in Botany and Zoology were introduced in the year 1978. Shri K. Dutta, Shri U. C. Kakati, Dr.S. N. Datta, Smti. A.Dutta and others contributed immensely towards the development of these departments. A good number of students brought laurels by securing distinguished ranks including the top in University examinations. Honours courses in Chemistry and Physics introduced in 1986 and 1987 respectively. Shri P. Deb and Shri R. K. Dutta nurtured these departments diligently during their tenure as head of the respective departments.

In the year1982 the college was accorded the U.G.C recognition under 2F and since then we have been receiving generous financial assistance for the development of infra-structure including library and laboratory up-gradation.

The Government of India formulated its National Policy on Education in 1986 (modified in 1992) laid great emphasis on computer education. The role of computer education in contemporary society, its applications, potential and use in everyday life were elaborated. A massive nationwide Computer Literacy programme was launched during 1990s through National Council of Educational Research and Training (NCERT).The project was intended to introduce computer education in schools and colleges.

Here too, the College did not lag behind and the subject Computer Application was introduced at the Higher Secondary level in the year 2001. Well equipped computer laboratory was inaugurated on 18th August 2003 with financial support received from North Eastern Council, Shillong. Honours courses in B. Sc Computer Science, Bachelor of Computer Applications (B.C.A), and Bachelor of Business Administration (B.B.A) were introduced in the year 2004 along with pass course in Statistics. The first ever B. Sc Honours course in Microbiology in the North Eastern Region of India was opened in this College in the year 2007. It may be mentioned that these developments were pursued during the tenure of Dr. (Mrs.) M. P. R. Lyngdoh as Principal of the College. Introduction of these new subjects certainly have benefited a number of students of the region including students from neighboring countries like Bhutan, Bangladesh and Burma, to acquire specialized knowledge at the door step within an affordable cost.

The College at present has roll strength of 2700 students, 115 teaching and over 40 non-teaching staff.

The Women's Hostel has been constructed recently out of partial financial grant received from the U.G.C, to accommodate girl students from rural areas of the state as well as students from other parts of the country. Financial assistance for construction of Men's hostel has been just received from U.G.C and the same is going to start soon. It may be mentioned here that recently the science departments of the college has been enriched with laboratory equipments worth Rs 50 lakhs by Department of Science and Technology (D.S.T), Government of India. The College has also received substantial financial assistance from U.G.C to construct the Indoor Sports Infra- structure and the foundation stone of the same is going to be laid by the Honourable Minister Dr. Raju in a short while from now.

In order to imbibe, inspire and empower our youths with scientific temperament along with their prescribed courses of studies, the college has been organizing a number of National Conferences/ Symposia/Workshops from time to time on various scientific and relevant themes. The college has a Women's Cell to look into the matter relating to gender equality, a research Committee to encourage and pursue minor research activities by teachers and students, Entrepreneurship Development Cell to impart training on self employment, Internal Quality Assurance Cell(IQAC)for recommending overall quality enhancement. National Cadet Corps (N.C.C), National Service Scheme (N.S.S), Rangers and Rovers, Youth Red Cross Society, Red Ribbon club are integral and important extension activities offered along with usual games and sports. Opportunities to the extent

possible are provided to the students for exhibiting their talent in the field of art, Culture and Music and if I may feel proud to mention that at least three students of this college perform as lead member of the famous 'The Shillong Chamber Choir'. One of our student has been selected to go to London and take training on Jazz and classical music

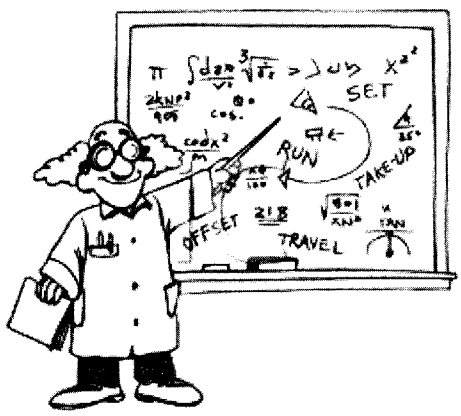
The college celebrated its Silver Jubilee and the Golden Jubilee in 1981 and 2006 respectively. In 2003 the college opted for assessment and accreditation by National Assessment and Accreditation Council (NAAC) and again reassessment and reaccreditation in the year 2010. At present, along with normal academic activities, we are exploring possibilities for introducing a few more job oriented courses, such as B. Sc in Information technology, Integrated courses like B.A-LLB, BBA-LLB, B.Com-LLB, Mass Communication, Fashion and Apparel designing, Vocational certificate/diploma courses like Carpentry, cane and bamboo furniture designing, Electronic Gadget repair and maintenance and some others. We also intend to introduce Post-Graduate Courses in the near future and from this year itself a few such programmes shall be started in collaboration with Indira Gandhi National Open University (IGNOU). We have recently acquired a plot of land measuring 7.33 acre at New Shillong for extension of the campus and drawn a road map for further development, such as play ground, swimming pool and other such sports facilities a summary of which I shall submit to the Honourable Union Minister for his kind approval, support and recommendations.

As I wind up a few persons whom I wish to remember with utmost respect notably the founder Principal Shri S. C. Dutta (1956-1970),Shri S. Bhattacharjee, former Principal (1970-1973), Shri D. S. Rawat, former Principal (1973-1990), Shri K. L. Choudhury, former principal (1990-1995), Shri T. Moitra, former principal (1995-1996), all the retired staff and two colleagues whom we have lost in 2012: Shri T. J. Kharbih, while serving as Head, Department of Chemistry and Shri W. Lawai, while serving as Senior lecturer, Department of Khasi.

Last but not the least I am highly indebted to Prof. K. S. Lyngdoh, President, Shillong College Governing Body, other honourable members and to my immediate predecessor Dr. (Mrs.) M. P. R Lyngdoh for having bestowed their confidence on me to carry forward the torch of Shillong College towards the Zenith.

Thank you all for being with us on this historical occasion.

Long Live Shillong College.



TEXT OF THE SPEECH BY DR. M. M. PALLAM RAJUM HO'BLE UNION MINISTER OF HUMAN RESOURCE DEVELOPMENT AT THE INAUGURAL FUNCTION OF THE GOLDEN JUBILEE OF TEACHING SCIENCE IN SHILLONG COLLEGE HELD ON 7TH JUNE, 2013, AT THE COLLEGE CAMPUS

Hon'ble Education Minister of Meghalaya, Dr. R. C. Laloo, Prof. K. S. Lyngdoh, President of Governing Body of Shillong College, Prof. A. N. Rai, Vice Chancellor of North Eastern Hill University, Dr. K. D. Ramsiej, Principal of the College, Smt. E. N. Dkhar, Convener of Golden Jubilee Celebration, former Principal of the College Dr. M. P. R. Lyngdoh, Principal Secretary of Education to the Government of Meghalaya, teachers, non-teaching staff, students, distinguished ladies and gentlemen:

At the outset I would like to thank you and the authority of Shillong College for inviting me for such a happy occasion. I am very pleased to be with you today. You can always relax as I am the last speaker today.

My heartiest congratulations to all the members of the Governing Body of the College, all the teachers, non-teaching staff and students of the college for completing 50 years of teaching science in this College, and celebrating the Golden Jubilee of Teaching Science in Shillong College. Shillong College was established in 1956 and has come a long way due to the selfless services of founder Principal Late Shri S. C. Datta and many others, other Principals, latest being Dr. (Mrs.) M. P. R. Lyngdoh and all the staff. Due to the efforts of all of them along with the teachers, non-teaching staff and the students, the College has reached to this level and became one of the premier institutes in Shillong. College has been running Science stream along with Commerce and Arts stream. I am happy to learn that the College has been running Professional Courses like B.B.A., B.C.A., B. Sc. (Mircobiology) and others. The college will be celebrating 50 years of teaching science on 23rd July and I understand that the College will organise various programmes like International Symposium on "Attracting Best Talents in Basic Science", Students Science Seminar, Science Exhibitions, alumni and past teachers meet etc. Actually there is going to be lot of activities and I am sure all of you will be enthusiastic participants in those programmes.

Coming to the subject, I think Vice Chancellor of NEHU, Prof. Rai, has elaborated quite a lot on the subject. Science today is life stream of the development of humanity and progress of mankind, and I think it is important that all are aware of what is happening all around us for our own progress and also enhancing our quality of life. You know that Science is having application in every sphere of life beginning with education, research areas, sports, music, culture, humanity, etc to every stage of life. Even in my previous job, I have travelled all around the country, the NCC camps, schools and colleges, and I had the opportunity to interact with lot of youngsters all over the country. The common thread that I have

found wherever I went is the confidence level that these young generation exhibit and this confidence level emerge primarily from their vast exposure because they surf mainly through the internet, watch television and I think they are much more aware of what is happening in the world today. I think it is on us the Government and the Society at large how much more we can do for these generation not only for their individual career but in order to prepare them for taking this country to better height. Definitely, a science foundation is a great beginning in this direction.

I am glad that Prof. Rai has informed me how the Department of Science and Technology, Government of India has funded 60 colleges in the North Easter region with Rs. 50 lakhs each with a provision that it is used for scientific laboratories which is the starting step and I hope we will be able to continue with the efforts in strengthening these areas. I think the other important aspect of any college being able to serve the students better is the kind of connectivity that you have and I was disheartened to know that it is very slow connectivity here but I hope that we will be able to establish fibre optic network that is laid all over the country and the LTN connection that the North Eastern Hill University will be getting. I am hopeful that we will be able to give high speed connectivity to the colleges that are affiliated tor the University and I do hope that this will make a difference in the quality of the internet and computer connectivity where the problem arises. I am sure that most of you are aware of the volume of information that are there and the whole purpose of the national knowledge network is to connect our campuses effectively so that there is sharing of information and development by the student community and also by the faculty. I think that this is the important development. I hope that this will be levelled upon by all the universities and colleges towards enhancing the knowledge base of the institutions and also towards facilitating the faculty and students data. I would urge upon the management and the Principal to review these progresses very thoroughly to ensure the facilities available to faculty and the students. There is a lot happening today in the sphere of education and you are aware that in last 5 year plan the Government of India has started so many new institutes all over the country whether it is now IITs, IISER and new National Institute of Technology (NITs), new Central Universities all these are to primarily widen the base of Higher Education. Because, as our children come out of schools and colleges, they need adequate institutions of higher learning and this has been an attempt to broad base higher education and there is a very ambitious attempt to take the general enrolment ratio in higher education from the present 18% which is recently reported to 30% by 2020.

So, I am sure that this are assumed targets and our technology friends and all of us will build the better connectivity. We have the distance mode of education. We have, you know, new stream of teaching that are emerging through courses that are online, courses like EDEX which are revolutionary in a way that education is imparted all over the world. I am sure we will be not far in adopting these technologies towards increasing the quality as well as the quantity of teaching that can be imparted to large number of people. Also, in today's era where teachers are in highly connected world where information are available online we must be able to facilitate our student to access to knowledge better and that is why the quality of connectivity is important not only in our colleges but also in our homes. So I think there is much work to be done on the connectivity sector and the Government of India, I am sure, will work hard in providing this connectivity.

A lot has been done in terms of strengthening the size of education in the country and again in the 11th 5 year plan we have started 5 new Indian Institute of Science Education and Research (IISER) all over the country which are doing very well. In fact, when I visited a couple of these institutes I was very happy to note that the enthusiasm of the students who are there. They wanted to become Ph. D.s, post doctoral scholars and some of them even want to work hard to win Nobel Prize. I think these have been facilitated by the atmosphere around those campuses. I think that is what is important today, you know, that a college, university, school, we as a society and teachers must be conscious about creating that environment on the campuses. It should be ideal environment not only for the faculty, it should be an environment to enable and encourage our students to work, it should be a campus which will make them thirsty for knowledge. I think, it is in our hands to grow potential in this area and this is the attempt of the Government of India to create such a an environment in the campuses and make it interesting for our children. We are trying to facilitate the laboratories in the colleges and universities and there is much more to be done. I think the other important aspect that would truly propel the level of education and development of science is the kind of linkages that we can have between the industries and the campuses. It is important to bring in the industry to do the relevant research and, you know, build a strategic linkage between the academics and the industry so that there is mutual inter-dependence and there is smooth transfer of knowledge between the two. This is something that is vital aspect that we are to develop in the coming years and I am sure this college will certainly rise up to the challenge.

Another important aspect, apart from education, which we have been working on, is to skill our youngsters. As you know, all over the country, some of our youngsters are not academically fine but, I am sure, they have flair of skills. I think we have to again create an environment in order to encourage them to find what would they do to earn a livelihood and going on that principle we need to strengthen our ITIs, polytechnics and also going into the concept of community colleges. Community colleges cater to the need of industries that are around the surrounding areas, also the hospitals, manufacturing establishments or the service industry etc and I think, it is important that we build up these community colleges as quickly as possible to cater to the local population and local needs. This is where we can train and teach our children and, I am sure that will go a long way. The Vice Chancellor of NEHU has been informing me that 5 to 6 community colleges have been granted to this region and I am sure you will try to find where you could fit in and some of the college would definitely adapt to this community colleges.

Once again, I would like to thank you all for inviting me in the happy occasion. I know that all of you are looking forward to the cultural programmes. So, I would like to give the space for you. All I want to say is that if all of us work together I am sure that we can create a very bright future for our children and it is on to us to see that we work fast in it in order to enable them to become better citizens and productive assets that will propel the nation forward.

THANK YOU. JAI HIND.

SHORT PROFILE OF DEPARTMENTS UNDER SCIENCE STREAM OF THE COLLEGE

The Science Stream in the College was inaugurated on 22nd July, 1963 and the classes formally started from 23rd July, 2013. As it happens in most of the cases, the classes in science departments (Chemistry, Physics, Mathematics and Biology) started with Intermediate or P. U. Section with skeletal staff who served initially as part-time teachers. Subsequently, teachers were appointed in regular basis and the college obtained the Deficit Grants-in-aid status from the State government with effect from 1st April, 1975 and that particular act of the then state government made the process smooth and strong. Since then the college did not look back and strived forward steadily to the present status. Profiles of the each of the Science departments are given below:

I. MATHEMATICS DEPARTMENT

Mathematics department of the Shillong College came into existence at the time of inception of the college in 1956 with the founder Principal (Late) Shri Sudhindra Ch. Datta, an eminent mathematician and author of popular book on Mathematics. The department was served by the following faculty members at different times (Late) Shri Sudhindra Ch. Datta,managing affairs of the department in addition to his administrative work along with some part-time teachers like Shri Prithwis Dutta, Shri A. Chakraborty and others. Shri Bankim Chandra Goswami joined the department on 29th March 1963 and then Shri Kalyan Kr. Choudhury on 15th July 1965 to be followed by Smt. Subhra Dhar in 1969. Dr. Hrishikesh Dhar joined in 1972 and the group of four teachers managed the department for several years till Dr. Bipul Shyam Purkayastha joined the Department in 1987. But he soon left the job to join an assignment in Assam University, Silchar and in his place Shri Dikes Shadap joined the department on 9th November 2000. Some other teachers also joined in the intervening period but left but their own career advancement and hence the department had to take the help of part-time teachers for many years. Shri Bankim Chandra Goswami retired from services in 2001 (as Vice-Principal) and in his place Shri Mardor Wanri Synrem joined the department on 1st September 2003. Shri K.K. Chaudhury retired from his long service in 2003 and in his place Shri Spainborlang Kharchandy joined the department on 1st September 2003, also Smt. S. Dhar retired in 2005 and in her place Shri Boringstill Diengdoh joined the department in 2005 but soon left the post to assume new assignment as Lecturer in District Institute of Educational Training (D.I.E.T.), Government of Meghalaya, and finally Dr. H. Dhar retired from service in 1st April, 2009. However Smt. J. Rivulet Gidon joined the department on 1st July 2008 in place of Shri Boringstill Diengdoh. On 17th June 2009, Shri Borometer Nongbri has joined our department in place of Former Head Of Department Dr. H. Dhar. The Department of Mathematics is proud to keep in record that Dr.

H. Dhar who has retired from services in our college in 31st March 2009 has resume another assignment as a Professor and Head of Department at the B. C. Roy Engineering College, Durgapur, West Bengal from May 2009. Shri Ebor Niang joined the Department on 1st June 2013 as Assistant Lecturer for the Higher Secondary Section.Honours Course, now known as Major course in Mathematics were started in the year 1966. The number of students admitted to the course is very encouraging and the result are very outstanding. The department is also associated with the Commerce, Arts Stream and also assisting the Professional Course like Bachelor of Computer Application.

Many other academicians served the department either as regular teachers or part-time teacher during all these years and we produce their names with gratitude: Shri, Prithwis Ch. Dutta, Shri Arun K. Bhattacharya, Shri Arun K. Biswas, Shri Shibo Prasanna Bhattacharjee, Shri Sibnath Bose, Shri B. J. Reddy, Shri Ajit Mishra, Smt. Sonali Sengupta, Shri Virgilius Nongbri, Smt. Anindita Bhowal, Smt. Sanchali Ghosh, Smt. Krishna Das, Smt. Nivedita Roy Chowdhury, Shri Borringstill R. Diengdoh, Smt. P. Lynser and Shri C. C. Kharsyntiew.

Present Teaching Staff of the Department

Sl. No.	Name	Designation	Qualification	Specialization	Date of Joining
1	Shri Dikes Shadap	Assistant Professor and Head	M.Sc, M.Phil	Number Theory	09-11-2000
2	Shri Mardor W. Synrem	Assistant Professor	M.Sc., M. Phil	Real Analysis	01-09-2003
3	Shri Spainborlang Kharchandy	Assistant Professor	M.Sc.	Theory of Relativity	01-09-2003
4	Mrs J. Rivulet Gidon	Assistant Professor	M.Sc.	Ring Theory	01-07-2008
5	Shri Barometer Nongbri	Assistant Professor	M.Sc.	Complex Analysis	19-06-2009
6	Shri Ebor Niang	Assistant Teacher	M.Sc.	Pure Mathematics	01-06-2013

GLIMPSE OF STUDENTS PERFORMANCE

The overall performance of students in the Department is satisfactory although only few students take Mathematics as Honours and sincere effort are being made to upgrade the standard of performance to higher level. In the past there were some outstanding results in examination conducted by North Eastern Hills University (NEHU), Shillong , but for sake brevity few results in recent times are given below:

1. Shri Sainkupar Mawiong earned the 1st Class 1st Position in B.Sc. Mathematics Hons in 2002.
2. Shri Barometer Nongbri earned the 1st Class 1st position in B.A. Mathematics Hons in 2006.
3. Shri Ebor Niang earned the 1st Class in B.Sc. Mathematics Hons in 2008.
4. Shri Reignbor Lang Marbaniang earned the 1st Class 1st position in B.Sc. Mathematics Hons in 2011.
5. Shri Shekstar Thabah earned the 1st Class 8th position in B. Sc Mathematics Hons in 2013 and Shri Khlian Borlang Warjri secured 1st Class. With the sincere efforts and cooperation of every faculty member, the department hopes that it will be able to answer and meet the aspirations**l.**

2. CHEMISTRY DEPARTMENT

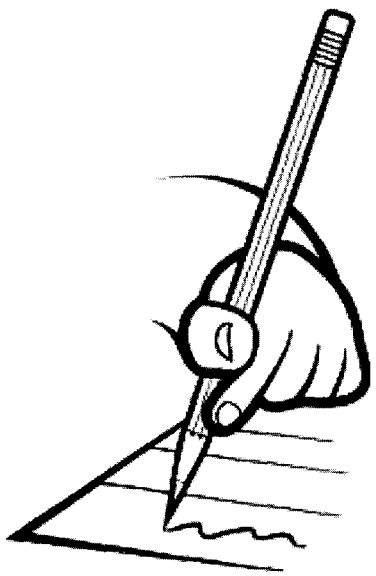
The Department of Chemistry, Shillong College was established, along with all other science departments, on 22nd July 1963 under the supervision of the founder Principal, (Late) Shri S. C. Datta. In its infancy, the department had a modest beginning when Dr. P. V. R. Rao (Lecturer, Lady Keane College) was looking after the department as a part-time teacher and later joined by Shri Kallpadi Nath as the Demonstrator. The department got its impetus when Shri Puroshottam Deb joined in March 1964 as a regular teacher and shaped the department with his innovative style till his untimely death in 1989. Since then, it was Dr. Sudhir K. Gupta who looked after the department as the head of the department. On his retirement, Shri Teibim Jala Kharbhih was anointed as the Head of the Department and he expired on 26th November, 2012, suddenly following cardiac arrest. At present, the department of Chemistry has five full time teachers, and they are: Dr. Manabendra Nath Bhattacharjee (Head), Dr. (Ms.) Deborah L. Buam, Shri Kenneth Umdor and Dr. Cheerful Masharing. Thanks to the progressive growth action of the management of the college, a new teacher has been appointed in the department for the Higher Secondary section and Miss Larica Pathaw has joined in the post with effect from 1st June, 2013. Apart from their normal routine duties, the lecturers in the department are also involved in other extra-curricular activities in the College like research activities, organizing seminars, conferences, etc. The Department has a well-equipped laboratory, a computer with internet facilities, the laboratory has a capacity of about 50 students, and the laboratory attendants, Shri Remilan Kharkongor and Smt Klestina Warjri remain engaged in keeping the laboratory tidy. The department started the Honours courses in Chemistry in 1986. The teachers of the department are dedicated and have keen.

Interest in shaping the student community towards a bright career prospect

Present Teaching / Non Teaching Staff of the Department

Sl. No.	Name	Designation	Qualification	Specialization	Date of Joining
1	Dr Manabendra Nath Bhattacharjee	Associate Professor and Head	M. Sc., Ph. D.	Inorganic Chemistry	29-07-1985
2	Dr. (Ms) Deborah L. Buam	Associate Professor	M. Sc., Ph. D.	Physical Chemistry	29-10-1991
3	Shri Kenneth Umdor	Assistant Professor	M. Sc., NET	Organic Chemistry	01-09-2003
4	Dr. Cheerfulman Masharing	Assistant Professor	M. Sc., Ph. D.	Inorganic Chemistry	01-07-2006
5	Miss Larica Pathaw	Assistant Teacher	M. Sc.	Physical Chemistry	01-06-2013
6	Miss Badaker M. Laloo	Assistant Professor	M. Sc.	Organic Chemistry	06-07-2013
7	Shri Remilan Kharkongor	Lab. Attendant			
8	Smt. Klestina Warjri	Lab. Attendant			

As the Department of Chemistry completes its 50 years of existence, we acknowledge the encouragement and cooperation from all section of the society. During all these years many other teachers served in the department as regular or part-time teachers. We gratefully acknowledge their selfless services and they are (in case any name is missed, it is totally unintentional or because our memory fails on certain occasions): Shri Prashanta Sharma, Shri S. Guha Thakurata, Shri Haripada Roy Choudhury, Dr. Rathindra Kr. Das, Shri Ramanda



Bhattacharjee, Shri Evans Rynjah Solomon, Shri Amalendu Hom Choudhury, Shri H. N. Paul, Shri R. C. Das, Shri Tushar Kanti Sen, Dr. M. L. Purkayastha, Shri Monoranjan Kalita, Dr. Abhijit Debroy, Shri S. C. Sinha, Dr. Parag Dhar Baruah, Shri R. Decruze, Dr. (Mrs.) Paramita Das, Shri Ratan Lal Gupta, Shri Jayatosh De, Smt. Amrita Roy, Shri Biswajit Roy, Smt. Jayati Sen Gupta, Shri K. R. Reddy, Smt. Sushmita Dutta, Smt. Jalareen Mannih, Shri Peter Glen Stone Dkhar, Shri P. M. Singh, and Shri Teibor Mukhim.

Student profile Students are admitted on merit basis and also on the basis personal interviews to judge the calibre of each of them. In the honours level admission, a cut-off mark is earmarked every year and the progress of the students is monitored more intrinsically. Most of the students belong to local Khasi (ST) community, though students are communities get equal opportunities. They are proficient in regional languages as well as in English. Considerable number of girl students also takes admission every year. Many students have excelled in the University examination and ranked amongst top ten on many occasions. Most of them have been pursuing higher studies in Chemistry and its allied branches

3. PHYSICS DEPARTMENT

Department of Physics was established in the year 1963 under the guidance and inspiration of the founder Principal (Late) Shri S. C. Dutta, to cater to the needs of the students aspiring to pursue collegiate education in the science stream and Shri Nalini Kanta Dey was the first teacher-cum-demonstrator in the department. However, he left the job soon.

Shri Abdul Martin was appointed as full time lecturer in 1963 to man the department in the initial stage when one year P.U (Sc.) course under Gauhati University was introduced. He left the college in 1964 and then two part time lecturers looked after the department. In the same year first batch of students in B.Sc. (1st year) of 3 yr degree course was admitted. In the later part of 1964, Shri Rajat K. Das joined as demonstrator to look after the P.U. practical classes. When the then H.O.D., Shri Ranjit K. Dutta joined in 1965, there were two part time lecturers and one demonstrator and the classes were P.U Sc(1yr), 1st and 2nd year B.Sc.(pass) of three year degree course. Dr. Udayan Ghosh joined the department in 1966 and Shri Durbadal Mukherjee joined in 1969 as full time lecturers. Subsequently, 2 yr P.U (Sc.) course followed by 2 yr degree (pass) course was introduced under North Eastern Hill University (N.E.H.U.) in 1974. The honours in Physics was introduced in 1989 and the first batch of students in B.Sc. (Hons.) appeared from our college in 1990. In 1994, Smt. E. N. Dkhar joined the department as full time lecturer and since then the department had been running with four full time teachers in 2001, Shri R. K. Dutta and Dr. U Ghosh retired in 2003. In 2003, on the retirement of Shri R.K. Dutta, Shri D Mukherjee took over as H.O.D. (Physics) and as the Vice Principal (regular courses) in 2005. Shri Snarmon Lato and Shri M. Rynjah joined the department in 2003 and 2004 respectively. In 2005, the demonstrator Shri R. K. Das also retired and his post which had been converted into a lecturer post was filled in by Shri A. Dkhar who joined the department in 2005. Meanwhile, Shri D.Mukherjee, retired from service in 2008,

Meanwhile, Shri D.Mukherjee, retired from service in 2008,and Smt. E.N. Dkhar took over as Head of the Department. The vacancy of Shri D. Mukherjee was later filled in by Shri L. Khongiang. At present, the department is functioning smoothly with five full time lecturers and one lab. Bearer Mr. Anil Kr. Khannal. From 1st June, 2013, Shri Kyrshan Nongbri also joined the department as assistant teacher in charge of Higher Secondary section. The department is manning the classes of the 3yr Degree course (Hons. & Pass) over and above class XI & class XII of + 2 level. With the introduction of BCA courses in 2004, the department is very much involved in taking theory and practical classes for Basic Electronics which is one of the papers in the above mentioned course. Some portion of Man and Environment paper for B.A, B. Sc and B.Com classes are also taken by the faculty members of the department.

During past years many other teachers served in the department as regular or part-time teachers. We gratefully acknowledge their selfless services and they are (in case any name is missed, it is totally unintentional or because our memory fails on certain occasions): Shri S. R. Paul, Shri Mridul Baral Paul, Smt. Nilima Das (Deb), Shri B. Goswami, Dr. Purnendu Bhattacharjee, Shri D. K. Nandi, Shri N. K. Arjun, Shri G. P. Pai, Shri G. C. Paul, Dr. B. J. Bhattacharjee, Smt. Sudipta Dey, Shri Ratan Chakraborty, Smt. Supriya Choudhury (Bhattacharjee), Shri Asiti Sarma, Shri B. K. Purkayastha, Shri Monkhmer Lyngdoh Kynshi, Smt. Sudipta Dey, B. Nongrum, K. R. Son, Shri R. S. Kharwanlang, I. Kharkongor, Smt. Sharmila Bhattacharjee, Smt. Cheerful Lyngdoh, Shri Simanta Chutia, B. Lyngdoh Giri, Shri M. Haque, I. B. R. Dkhar, Shri Donbor Rapsang, Shri R. Nongkhlaw, Shri N. P. War, Shri J. Williamson LGidon, Shri Pankaj Tamang.

Present Teaching / Non Teaching Staff of the Department

Sl. No.	Name	Designation	Qualification	Specialization	Date of Joining
1	Smt. E.N. Dkhar	Associate Professor and Head	M. Sc. (NEHU)	Laser physics	01.09.1994
2	Shri S. Lato	Assistant Professor	M. Sc. (NEHU)	Condensed matter physics	01.09.2003
3	Shri M. Rynjah	Assistant Professor	M. Sc. (NEHU)	Solid state physics	14.08.2004
4	Shri A. Dkhar	Assistant Professor	M. Sc. (NEHU) NET	Laser physics	02.07.2005
5	Shri L. Khongiang	Assistant Professor	M. Sc. (NEHU) NET	Nuclear physics	01.07.2008
6	Shri Kyrshan Nongbri	Assistant Teacher	M. Sc. (NEHU)		01.06.2013
7	Shri Anil Kr. Khannal	Lab. Attendant			

Academic Performance of the Students - The academic Performance of the students in the B.Sc. Final Examination has been consistently good over the years as a result of the regularity and sincerity on the part of the teachers and hard work of the students. Individual care is taken in general, and for weaker students in particular, due to which usually the percentage of pass remains above the University Pass percentage. The academic performances of the students have been more than encouraging and the department produced quite a good number of 1st class (Hons.) graduates over a span of the last 18 years. To mention a few, Shri Subho Das secured 1st class 2nd position in B.Sc. (Hons.) in 1997 and Shri Regenelson Kharwanlang secured 1st class 1st position in B.Sc. (Hons.) in 1999, Shri Albansius John Buhphang and Shri Tisharlin S Mawdoh secured 1st class 6th and 7th positions respectively in 2002, Shri Mebantip Thabah secured 1st class 5th position in 2003. In 2009 Shri Ram Chandra Ray secured 1st class 10th position in B.Sc. (Hons).

4. ZOOLOGY DEPARTMENT

The Department of Zoology started in 1963, when Science Section was opened in Shillong College, under Gauhati University. Late Prof. Kamalakshya Dutta was founder Head of the Department of Zoology of this College. At that time one-year P.U. course was there and subsequently in 1964, B.Sc. three years Degree Course was started. Late Prof. K. Dutta worked as head of the Department of Zoology till his retirement on 14th. December 1991. In the year 1966, Mr. Parimal Chakravorty and Dr. Pronab Mukherjee joined the Department as Demonstrator and lecturer respectively. Dr. Mukherjee left Shillong College in 1968 to join Surendra Nath College at Kolkata. Shri Jahnabi Kumar Chattoraj joined as lecturer in Zoology in 1968 and worked up to 1972 and left this College to join Bankura Christan College in west Bengal. Mr. P. Chakroborty worked as Demonstrator till 1972 and resigned from the job to join LICI. Dr. Samarendra Nath Dutta joined the department in the year 1969 and became the head of the department in 1991 following the retirement of Prof. K. Dutta and served till his retirement in the 2003. He was then succeeded by Mrs. Rekha Devi who joined the department in 1972 and served till she retired in 1st September 2008. In 1974, Mrs. Suparna Choudhury joined the department as a demonstrator, which was later upgraded to lectureship and was in the post till her retirement in March 2009. As the time passes on the Department started to develop and new teachers joined the Department as Lecturer in the following order:-

Present Teaching / Non Teaching Staff of the Department

Sl. No.	Name of Lecturer	Designation	Qualification	Specialization	Date of Joining
1	Dr. Malay Dey	Associate Professor and Head	M.Sc., Ph. D. (NEHU)	Cytogenetics	08.07.1985
2	Mrs. Daisa Nora Shabong	Associate Professor	M.Sc. (NEHU)	Cytogenetics	01.09.1994
3	Ms Eva M. Pala	Assistant Professor	M.Sc. (NEHU), NEHU	Endocrinology & Reproductive Biology	05.07.2005
4	Ms Lucy Mary Jyrwa	Assistant Professor	M.Sc. (NEHU), NET, Ph. D. (NEHU)	Biochemical adaptation	06.09.2008
5	Dr. Shanwell Khongwir	Assistant Professor	M.Sc. (NEHU) NET	Dev. Biology, Ecology and Breeding	02.03.2009
6	Shri Banrilang Dohling	Assistant Teacher	M. Sc.		01.06.2013
7	Shri E. Pyrtuh	Lab. Attendant			

As the Department of Zoology completes its 50 years of existence, we acknowledge the encouragement and cooperation from all sections of the society. During all these years many other teachers served in the department as regular or part-time teachers. We gratefully acknowledge their selfless services and they are (in case any name is missed, it is totally unintentional or because our memory fails on certain occasions): Shri J. J. Rao, Shri A. Roy, Smt. Jennifer Lyngdoh, Shri Himangshu Banerjee, Shri Dhiresh Ch. Dhar, Shri Monoranjan Barman, Shri S. K. Aditya, Shri Amitabha Mishra, Shri Amal Kanti Chakraborty, Shri K. K. Dutta, Dr. Bidhan Bhattacharjee, Dr. M. Challam and Shri Donald Jyrwa.

5. BOTANY DEPARTMENT

The Department of Botany came into being in the year 1963 with Pre university course under Guwahati University. Shri U. C. Kakati was the first full time lecturer, who joined in 1964 and nurtured the Department as HOD till his retirement as Vice Principal in 2001. Since its inception, the Department has grown from strength to strength year by year. The Degree Pass course was started in 1966 and Honours course was started in 1979. Since then till now, the Department has come a long way which at present has five full time qualified lecturers, one assistant teachers (for higher secondary section) and a laboratory assistant. They are:

Present Teaching / Non Teaching Staff of the Department

Sl. No.	Name of Lecturer	Designation	Qualification	Specialization	Date of Joining
1	Shri. S. K. Roy	Associate Professor and Head	M.Sc. (Bot.) L.N. Mithila Univ.)	Cytogenetics and Plant Breeding	26-11-1993
2	Smti. D. Kharshandi	Associate Professor	M, Sc. (Bot.) (NEHU)	Forest Ecology	18-04-2002
3	Smti. M. V. T. Marwein	Assistant Professor	M, Sc. (Bot.) (NEHU)	Forest Ecology	20-01-2003
4	Smti. D. Lyngdoh	Assistant Professor	M, Sc. (Bot.) (NEHU)	Taxonomy	01-09-2006
5	Smti. A. Lyngdoh	Assistant Professor	M, Sc. (Bot.) (NEHU)	Fungi pathology	01-07-2008
6	Smt. Daphi Lakmen Kharmon	Assistant Teacher	M. Sc.		01-06-2013
7	Smt. F. Kharlukhi	Lab. Attendant			

As the Department of Botany completes its 50 years of existence, we acknowledge the encouragement and cooperation from all sections of the society. During all these years many other teachers served in the department as regular or part-time teachers. We gratefully acknowledge their selfless services and they are (in case any name is missed, it is totally unintentional or because our memory fails on certain occasions): Shri S. R. Das, Shri Rajat Kanti Bhattacharjee, Smt. Joyce Mehra, Smt. Anjali Dutta, Dr. (Mrs.) Ayesha Ashraf Ahmed, Miss K. Dutta, Dr. N. I. Singh, Dr. Bhaskar Neogi, Shri A. B. Dutta, Shri R. B. Chettri, F. S. Khonglah, Shri S. Myrthong, Shri Subhashis Das Gupta, Abha Sarma, Shri M. C. Paul, Shri Atunu Kr. Das, M. B. Hynniewta, J. P. Marak.

Lecturers of Botany are actively engaged in the overall development of the College. In addition to the primary duties of teaching, the lecturers of Botany Department constantly strive to update their knowledge by regularly attending and participating in various seminars, workshops and training programmes for the benefit of the students. The department has a laboratory which can accommodate 50 students approximately. The department has all the required Scientific equipment and facilities such as Computer system with Internet facility, Microscope (Monocular, Binocular, Trinocular, Projection), Spectrophotometer, Hot air oven, Incubator, Balance (single pan, double pan), Hot plate, Water distillation unit (glass, double), Inoculation chamber, Centrifuge, Autoclave etc.

To groom up the students to face today's competitive world, the department has started a dream project called "Botanic Club" since 3rd of December, 2003. Botanic Club organises students' seminar and discussions from time to time to provide a platform for the students to

express their views. The Club has also published two issues of a magazine called 'Botane' with articles contributed by the student members of the department. Training Programmes, Popular Talks and Seminars by reputed personalities are organised in the Department to sensitize the students regarding current scientific issues

6. COMPUTER SCIENCE DEPARTMENT

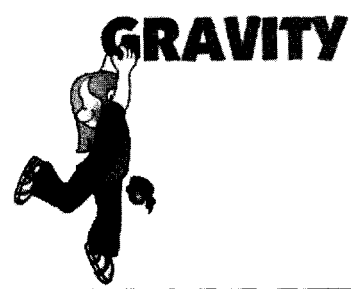
Background

In the past few years, education scenario in Shillong and Meghalaya has seen many changes. Efforts were made to bring about an environment and a level of education that were at par with those of other cities in the country. This saw the establishment of new courses of study in the colleges in Shillong; these courses, the pursuit of which would have only been possible outside Meghalaya and this too, for only a very few students.

In 2003, with this objective in mind, and with the world at large having recognized the vast possibilities of Computer Science and Information Technology and the impact it has made on every human activity, Shillong College felt a need to set up a department of Computer Science and the conduct of courses under it.

The courses offered are bifurcated into two broad streams Bachelor in Computer Applications and B.Sc. (Computer Science), both affiliated to N.E.H.U. The Department is also responsible for conducting classes in Computer Science in other streams such as those in the Higher Secondary courses, B.Com, B.B.A etc., However, the College is considering incorporating other short term courses into the department sometime in the near future. At its inception, the department functioned under the headship of Shri. Pynnianglut Hadem (MCA) for a term of one year from 2003 to 2004 and which was taken over by Shri. Gordon K. Nongkynrih, from 2004 to 2006; the present Head of the Department Smt. A. M. Mitri took over in 2006. The Department of Computer Science and Applications functions under the supervision of the Vice-Principal of Professional Courses who is the overall in-charge.

The Department of Computer Science and Applications is fortunate to have many other teachers in its faculty who had to leave the job for better opportunities, and they are: Shri Geoffrey M. Shadap, Shri Willford Thangkhiew, Shri Jeremy Kharshandy, Smt. Ibansharai M. Marbaniang, Smt. I. Nongrum, Shri S. S. War, Shri Sharad Chettri, Shri Macdonald S. Mawrie, Shri N. Donald J. Thabah, Shri David Cooper Kharpuri, Shri P. Kharmawphlang, Shri S. Wahlang, Smt. Merlycia Kharmawphlang, Shri Shanborlang Warjri, Shri J. Wahlang, Smt. W. C. Kharkongor, Shri Hardy Nelson Diengdoh, , Shri Ksan Kupar Swer, Smt. Parisha T. Rapsang, Shri Challenge S. G. Kharjana, Shri Brighstar Wanswet, Smt. Milky Wayne Diengdoh, Smt. Darina L. Mawphlang and Shri Lawin Kharmujai.



Present Teaching / Non Teaching Staff of the Department

Sl. No.	Name	Designation	Qualification	Date of Joining
1	Smt. Aiom M. Mitri	Assistant Professor and Head	M. Sc. (Comp. Sc.),M. Phil. NET	04-08-2004
2	Shri Banteilang Mukhim	Assistant Professor	MCA	
3	Smt. Ibalarihun Sun	Assistant Professor	M.C.A.(Nagpur Univ.)	02-06-2008
4	Ms. Ibameda Kharmwphlang	Assistant Professor	M.C.A. (Dib. Univ.)	01-05-2010
5	Shri Teiborlang S Warjri	Assistant Professor	M. Sc. (Comp. Sc.) (Bharatidasan Univ., TN)	01-05-2010
6	Pynshngianlang Nicholas Jyrwa	Assistant Professor	B. Tech. (Comp. Sc. & Engg.) (UPTU)	01-05-2010
	Shri Ransly Hoojon	Assistant Teacher	M. Sc.	
	Shri A. Sawian	Lab Attendant		

7. STATISTICS DEPARTMENT

Considering the importance of Statistics, Shillong College opened the Department of Statistics in the year 2004 by appointing one teacher, Mr. Sankar Goswami, and admitting 10 class XI students with subject combinations (i) Statistics, Mathematics and Economics; and (ii) Statistics, Mathematics and Physics. In the year 2005, the department had started undergraduate courses. One more teacher, Ms. Puspita Das was appointed and students were allowed to take Statistics as a general paper in B.A. / B.Sc. 1st year with subject combinations (a) Statistics, Mathematics and Physics; and (b) Statistics, Mathematics and Economics. Now the department is offering one more combination viz. Statistics, Mathematics and Computer Science for class XI and undergraduate level. Till today the pass out percentage of the students of the department has been recorded almost 100 percent. However, the first faculty member of the Department, Shri Sankar Goswami, has left the job and now is appointed as Assistant Professor in Guru Charan College, Silchar, Assam.The Department of Statistics is fortunate to have many other teachers in its faculty who had to leave the job for better opportunities. We gratefully acknowledge their selfless services and they are: Shri Sangku Dey and Shri Jamil R. Swer.

The department organized a seminar on "Prospects and Applications of Statistics" on 27th June, 2009. The theme of the seminar was importance, prospects and applications of statistical techniques in various fields. The seminar was open for Teachers, Research Scholars and Students of Statistics/ Mathematics.

Students' Achievement: In 2008 Shri Hubert Lyngkhoi was awarded by The Chief Minister, Meghalaya, for securing highest mark in Statistics in class XII MBOSE exam. In 2009 Ms. Persara Kharluni secured highest mark in Statistics in class XII MBOSE exam.

Mr. Lambha Kharkongar under the guidance of Dr S.K Gupta, Vice Principal (Professional Course) with 16 Students intake. In 2008, Ms. Mary Diengdoh joined as Lecturer while Ms. Ibandarisuk Lyngdoh and Ms. Naphibanmer Wankhar joined the Department as Lecturer in February, 2010 and March, 2010, respectively.

Department of Microbiology has developed and transformed itself into a progressive Department with up-to-date laboratory equipments, reference books and balanced course distribution at all the 3 years of study. Lectures, Seminars, Assignment, Class tests and Practical are being conducted regularly to

Present Teaching / Non Teaching Staff of the Department

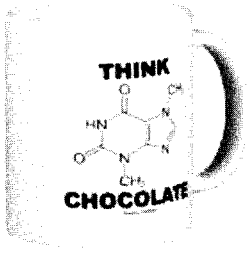
Sl. No.	Name	Designation	Qualification	Specialization	Date of Joining
1	Smt. Puspita Das	Lecturer and Head	M.Sc., (Gauhati Univ.)	Demography	03-07-2006
2	Shri Don Manik Syiem	Lecturer	M.Sc. (NEHU)	Operation Research	01-06-2009
3	Smt. Ibalucky Shisha Khyriem	Lecturer	M.Sc. (NEHU)	Operation Research	02-09-2011

8. MICROBIOLOGY DEPARTMENT

Shillong College has the credit of being the first college to offer B. Sc (Microbiology) Honours in the state of Meghalaya. The Department was started from the academic session 2007-2008 and it is indeed the youngest Department out of the Departments existing in Shillong College.

The Department of Microbiology started with a Team of two Lecturers, Mr. Zoliansanga (Head of the Department) and Ms. Pynhunshisha Kharkrang and one Laboratory Attendant,

improve the performance of the Students. It is progressing steadily under the guidance of the Principal, Vice Principal (Professional Courses) and the faculty members to achieve its dream of excellence.



Present Teaching / Non Teaching Staff of the Department

Sl. No.	Name	Designation	Qualification	Specialization	Date of Joining
1	Shri Zoliansanga	Lecturer and Head	M.Sc. (Univ. Of Pune)		01-05-2007
2	Smt. M. Diengdoh	Lecturer	M.Sc. (Bangalore Univ.)		01-06-2008
3	Smt. P. Kharkrang	Lecturer	M.Sc. – Microbiology (Periyar Univ.)	Applied Microbiology	01-06-2008
4	Smt. Ibandarisuk Lyngdoh	Lecturer	M.Sc. (Periyar Univ.), Ph. D. (NEHU	Applied Microbiology	Feb, 2010
5	Smt. W. Lytand	Lecturer	M.Sc. (Bangalore Univ.)		08-08-2011

9. ENVIRONMENT SCIENCE

In response to the honorable Supreme Court directive to make all curricula environment-oriented so as to create environmental awareness among all Indian Citizen, the studies on Environment Science commenced in the college in 2007 with Smt. P. M. Kharkongor as in-charge teachers with part-time duty. In 2008, it was Smt. P. Kharbyngar who looked after the department. Since 1st June, 2009, the College has created a regular post in the department and Smt. M. B. Lynser joined the department as the first full time teacher on the same day. Till now it is a one staff department with occasional help from part-time teachers. It is yet to become a full fledged Department. At present no honours (major) courses is offered but the Department is managing two compulsory papers i.e., Environmental Education for Class XI and Class XII of Arts, Commerce and Science streams and Environmental Studies for III yr Degree of Arts, Commerce and Science streams and Professional Courses. In its initial stage, there was only one teacher Ms. M. B. Lynser, who joined the Department as the first regular Teacher on 1st June, 2009. However, with a steady increase in the number of students as well as the corresponding academic and extra-curricular duties, two additional part-time faculties, Mr. Lawin C. J. Lyngdoh and Ms. B. S. Challam were appointed in 2012 and 2013 respectively.

The two faculties who are presently managing the Department are:-

1. Marvellous B. Lynser
2. Beula Sharon Challam

Apart from fulfilling the syllabus requirements in terms of lectures, assignments and project works, the teachers are also involved in social and extra-curricular activities within and outside the college. They are involved in organizing various programmes (training programmes, competitions, etc.) together with the Department of Botany in the college. Both the teachers are actively involved in scholarly activities and are pursuing their respective doctoral degrees. Ms M. B. Lynser works on Forestry and Livelihood related issues and Ms. B. S. Challam on Industrial Pollution.

NAMES OF THE FIRST BATCH STUDENTS ENROLLED IN SHILLONG IN THE YEAR 1963

[College started the Science stream in the year 1963 with only Pre-University (Day) section – Degree classes were introduced in the subsequent year.]

Sl. No.	Name	Sl. No.	Name	Sl. No.	Name
1	Rathindra Dhar	48	Asoke Ch. Chakravarti	95	Ranajit Kumar Das
2	Manwaruddin Ahmed	49	Pankaj Kanti De	96	Satish Chandra Brahma
3	Home Singh Buhroy	50	Gouridas Roy	97	Mihir Chandra Basumatari
4	Provangshu Gupta Chaudhury	51	Kishor Kumar Bhattacharjee	98	Bidhan Ch. Paul Choudhury
5	Sukomal Dey	52	Subir Kumar Deb	99	Mahesh Chandra Ghose
6	Mintu Kumar Borah	53	Mrinal Kr.Purkayastha	100	Golap Chandra Gogoi
7	Bhairab Ch. Narjary	54	Asoso Kholi Mao	101	Chandra Prasad Gurung
8	Lalringliana	55	Pradip Kar	102	Amiya Kumar Mandal
9	E. Jessonyimo	56	Rajat Kumar Saha	103	Maniram Musahary
10	Alumo Lotha	57	Dibakar Sen	104	Brojendra Nath Brahma
11	Goutam Kr. Bhattacharya	58	Gouri Sankar Mitra	105	Bonowari Lal Das Gupta
12	Sat Chandra Varma	59	Manik Lal Sarma	106	Sudatta Choudhury
13	Kithezogo Lotha	60	Neikhano	107	Debapriya Das
14	Abemo Lotha	61	Gopal Singh Chhetri	108	Priyaranjan Choudhury
15	Benchu Mo Lotha	62	Nirajnan Das	109	Palakdhari Sonar
16	Nil Madhab Rajkumar	63	Daksha Das	110	Promod Ch. Dhekial
17	A. Yashilemba Ho	64	Sudhangshu Dey	111	Prajapati Roy
18	Sasinath Deori	65	Debasankar Roy	112	Md. AbduRahman
19	Tarun Chandra Deka	66	Ashish Das Gupta	113	Md. Abdul Mattib
20	Gopi Mohan Roy Kuer	67	Mahendra Nath Baruah	114	Rabin Hazarika
21	Sukesh Ranjan Talukdar	68	Mohd. Jaiyal Ahmed	115	Nibaron Panchanon
22	Bhabani Prasad Chakravarti	69	Ramshighason Suklavaidya	116	Dinesh Chandra Chakravarti
23	Promoth Kumar Roy	70	Amir Lal Roy	117	Biraj KumaBhuyan
24	Pradeep Kumar Thapa	71	Kalyan Goswami	118	Ganesh Baral
25	Thommon Kharkongor	72	Ayekpam Munal Singh	119	Bijoy Kumar Das
26	Ratan Datta	73	Mrinalini Bhattacharya	120	Purnendu Bhusan Dhar
27	Budheswar Chuttia	74	Mrinmay Bhattacharya	121	Monojit Das
28	Mohan Chandra Malakar	75	Lalit Chandra Hazarika	122	Nilabhusan Deb
29	Jamuna Prasad Singh	76	Pravat Singh Deka	123	Sushanta Kumar Bagchi
30	Ajit Kr. Datta Purkayastha	77	Nonigopal Dey	124	Bijoy Krishna Endow
31	Haripada Dhar	78	Suryya Kumar Sarma	125	Dambor Bhatta Rai
32	Indreswar Nath	79	Ramani Kumar Barooah	126	Anil Kumar Bezbaruah
33	Mrinal Kanti Goswami	80	Jagadindra Nath Kar	127	Paresh Chandra De
34	Umakanta Bhuyan	81	Kanakeswar Saikia	128	Ekraj Sharma

35	Ramoy Sinha	82	Sarat Chandra Datta	129	Basudev Subba
36	Khagendra Mahanta	83	Krubizolie Pessy	130	Tapendra Kr. Bhattacharya
37	Gopal Chandra Das	84	Navin Kumar Sharma	131	Edwinston Lungkumar
38	Ranjit Choudhury	85	Jyoti Prakash Deb	132	Joshekaloa Ao
39	Nripendra Ch. Mazumdar	96	Sankheswar Kalita	133	Biswajit Goswami
40	Ka Pukeni Mao	87	Sishir Kumar Talukdar	134	Bhanu Ram Pegu
41	Jitendra Nath Kakoty	88	Sova Ram Gogoi	135	Nanalan
42	Pradeep Chandra Gohain	89	Sitesh Purkayastha	136	Pradip Kr. Gupta
43	P. Yanger Ao	90	Rathindra Nath Banerjee	137	Dwijendra Lal Choudhury
44	Arabinda Baruah	91	Abdul Sattar Mia	138	Girish Borah
45	Jatindra Nath Barua	92	Manik Lal Roy	139	Subrata Purkayastha
46	Paritosh Som	93	Atish Kumar Datta	140	Arunachal Shome
47	Jitendra Nath Kakoty	94	Parthasarathi Syam	141	Rupak Choudhury

OUR STUDENTS MAKE US PROUD

Whereas the details of all the distinctive results in the Science Stream in the past are not available, we present here some glimpses of such results of the past and more detail of the present:

Year	Name of the Student	Examination	University/Board	Rank/Position
1971	Smt. Aparna Das	B. Sc.	Gauhati Univ.	Distinction/8th rank
1976	Shri Priyatosh Chakraborty	B. Sc.	NEHU	Distinction/1st rank
1979	Shri Arvind Singh Sehdave	P. U. Science	NEHU	8th
1981	Shri Malay Dey	B. Sc. - Honours	NEHU	1st Class 1st
1982	Shri Palash Kumar Mazumdar	B. Sc. - Zoology Honours	NEHU	1st Class 4th
1986	Emily Chrisatrine Rozario Brisohbar	B. Sc. - Zoology Honours	NEHU	1st Class 3rd
	Smt. Ibanri Hynniewta	B. Sc. - Zoology Honours	NEHU	1st Class 4th
1989	Smt. Mousumi Bhattacharjee	B. Sc. - Botany Honours	NEHU	1st Class 2nd
	Smt. Mousumi Paul	B. Sc. - Chemistry Honours	NEHU	1st Class 5th
1990	Smt. Mithua Bhattacharjee	B. Sc. – Chemistry Honours	NEHU	1st Class 3rd
	Smt. Mandira Bhowmik	B. Sc. – Chemistry Honours	NEHU	1st Class 6th
	Shri Fredrick A. Lamare	B. Sc. IInd Year Pass	NEHU	1st Class 6th
1991	Smt. Sima Rani Prasad	B. Sc. - Chemistry Honours	NEHU	1st Class 1st
	Shri Fredrick A. Lamare	B. Sc. – Zoology Honours	NEHU	1st Class 1st
	Smt. Banani Nandi	B. Sc. – Botany Honours	NEHU	1st Class 2nd
	Smt. Gopa Sarma	B. Sc. – Botany Honours	NEHU	1st Class 3rd
	Smt. Barnali Purkayastha	B. Sc. – Physics Honours	NEHU	1st Class 6th
	Smt. Mandira Paul	B. Sc. – Physics Honours	NEHU	1st Class 10th

1992	Smt. Sanhita Bhattacharjee	B. Sc. – Zoology Honours	NEHU	1st Class 2nd
	Smt. Debashree Dam	B. Sc. – Zoology Honours	NEHU	1st Class 4th
	Smt. Manisha Deb	B. Sc. – Zoology Honours	NEHU	1st Class 5th
	Shri Swapan Kr. Sinha	B. Sc. – Botany Honours	NEHU	1st Class 2nd
	Shri Kulbir Bhujel	B. Sc. – Botany Honours	NEHU	1st Class 3rd
	Smt. Phuhlin Mukhim	B. Sc. – Physics Honours	NEHU	1st Class 8th
	Smt. Tanushree Biswas	B. Sc. – Physics Honours	NEHU	1st Class 10th
1993	Shri Subho Das	B.Sc. – Physics Hons.	NEHU	1st class 2nd
	Shri Joydeep Paul	B. Sc. – Mathematics Honours	NEHU	1st Class 4th
	Shri Jasobonto Bhattacharjee	B. Sc. (Pass)	NEHU	1st Class 5th
1994	Smt. Anamika Gupta	B. Sc. Zoology Honours	NEHU	1st Class 1st
1996	Smt. Anju Kumari Rawat	B. Sc. – Botany Honours		1st Class 8th
1999	Shri Regenelson Kharwanlang	B. Sc. Physics Honours	NEHU	1st Class 1st
2002	Shri Sainkupar Mawiong	B.Sc. - Mathematics Hons	NEHU	1st Class 1st
	Albansius John Buhphang	B. Sc. - Physics Honours	NEHU	1st Class 6th
	Shri Tisharlin S. Mawdoh	B. Sc. - Physics Honours	NEHU	1st Class7th
2003	Shri Mebantip Thabah	B. Sc. - Physics Honours	NEHU	1st class 5th
2004	C. Vanlalveni	B. Sc. – Botany Hons.	NEHU	1st Class 4th
	Larisuk B. Lynser	B. Sc. – Botany Hons.	NEHU	1st Class 5th
2006	Shri Barometer Nongbri	B.A. in Mathematics Hons	NEHU	1st Class 1st
2007	Gangte J. Samuel	B. Sc. – Zoology Honours	NEHU	1st Class 2nd
2008	Smt. Sita Bisukarma	B. Sc. - Chemistry Hons.	NEHU	1st Class 2nd
	Smt. Gita Bisukarma	B. Sc. - Chemistry Hons.	NEHU	1st Class 2nd
	Shri Shngainlang Khongsti	B. Sc. – Zoology Hons.	NEHU	1st Class 7th
2009	Shri Reuben Joey Mawthow	B.C.A.	NEHU	Ist Class 2nd
	Genie Wonreichen Pheirim	B. Sc. Zoology Honours	NEHU	Ist Class 4th
	Freeman Anthony Khongshai	B. Sc. Botany Honours	NEHU	Ist Class 7th
	Shri Konbilan Nongrang	B. Sc. Chemistry Honours	NEHU	Ist Class 10th
	Shri Ram Chandra Ray	B. Sc. Physics Honours.	NEHU	Ist Class 10th
2010	Shri Buddha Gangula	B. Sc. (Hons.) Zoology	NEHU	
	Shri Wanchirup Chen	B. C.A.	NEHU	
	Smt. Daphibahun Shabong	B.C.A.	NEHU	
	Shri Monoranjan Boro	B. Sc. (Hons.) Microbiology	NEHU	
	Smt. Alarisa Khyllep	B. Sc. (Hons.) Microbiology	NEHU	1st Class Second
	Smt. Clarisa Syiemlieh	B. Sc. (Hons.) Microbiology	NEHU	1st Class Third
	Smt. Jedidaya Synnah	B. Sc. (Hons.) Microbiology	NEHU	1st Class Fourth
	Shri Samson Sumer	B. Sc. (Hons.) Microbiology	NEHU	1st Class Fifth
	Shri Kanhaiya Pathak	B. Sc. (Hons.) Microbiology	NEHU	1st Class Sixth
	Smt. Lawanpli Khongsit	B. Sc. (Hons.) Microbiology	NEHU	1st Class Seventh

2011	Shri. Reignborlang Marbaniang	B. Sc. (Hons.) Mathematics	NEHU	1st Class First
	Sonia P. Kharlukhi	B. Sc. (Hons.) Zoology	NEHU	1st Class Fifth
	Kaminthangthang Hilsiam	B. Sc. (Hons.) Zoology	NEHU	1st Class Eighth
	Darikynti Kharmawlong	B. Sc. (Hons.) Computer Science	NEHU	1st Class Tenth
	Khrawkuparlang Nongkynrih	B.C.A.	NEHU	1st Class Third
	Daminot Pyngrope	B. Sc. (Hons.) Microbiology	NEHU	1st Class First
	Dalamphang Kharkongor	B. Sc. (Hons.) Microbiology	NEHU	1st Class Second
	Ganelsen Nongphud	B. Sc. (Hons.) Microbiology	NEHU	1st Class Third
	Welfareson Khangliah	B. Sc. (Hons.) Microbiology	NEHU	1st Class Fourth
	Sendermoon Nongrum	B. Sc. (Hons.) Microbiology	NEHU	1st Class Fifth
	Shapharang B. Khonglam	B. Sc. (Hons.) Microbiology	NEHU	1st Class Sixth
	Samborlang Syiem	B. Sc. (Hons.) Microbiology	NEHU	1st Class Seventh
	Zasse D. Arengh	B. Sc. (Hons.) Microbiology	NEHU	1st Class Eighth
2012	Shri Wadborlang Wahlang	B. Sc.(Hons.) - Physics	NEHU	Ist Class Fourth
	Balasara Kshiar	B.C.A.	NEHU	Ist Class Second
	Bhaboklang Rynjah	B.C.A.	NEHU	Ist Class Fourth
	Vansant Rangslang	B.C.A.	NEHU	Ist Class Fifth
	Yengkhom Bigya Devi	B.C.A.	NEHU	Ist Class Tenth
	Abednego Chhailo	B. Sc. (Hons.) - Microbiology	NEHU	Ist Class First
	Augustine Lamin Ka-ot	B. Sc. (Hons.) - Microbiology	NEHU	Ist Class Second
	Abbas Hussain	B. Sc. (Hons.) - Microbiology	NEHU	Ist Class Third
	H Nakibapher J. Shangpliang	B. Sc. (Hons.) - Microbiology	NEHU	Ist Class Fourth
	Wanrisa Marbaniang	B. Sc. (Hons.) - Microbiology	NEHU	Ist Class Fifth
	Kyrshanbor Snaitang	B. Sc. (Hons.) - Microbiology	NEHU	Ist Class Sixth
2013	Chalbasson Lyngwa	B. Sc. – Botany Hons.	NEHU	Ist Class 7th
	Wandanylla Rani	B. Sc. - Computer Science	NEHU	Ist Class 9th
	Shekstar Thabah	B. Sc. – Mathematics Hons.	NEHU	Ist Class 8th
	Reuben Swer	B. Sc. – Zoology Hons.	NEHU	Ist Class 6th
	Chinneilhing Touthang	B. Sc. - Zoology Hons.	NEHU	Ist Class 9th
	Rohit Mani Yadav	B. Sc. - Microbiology	NEHU	Ist Class 1st
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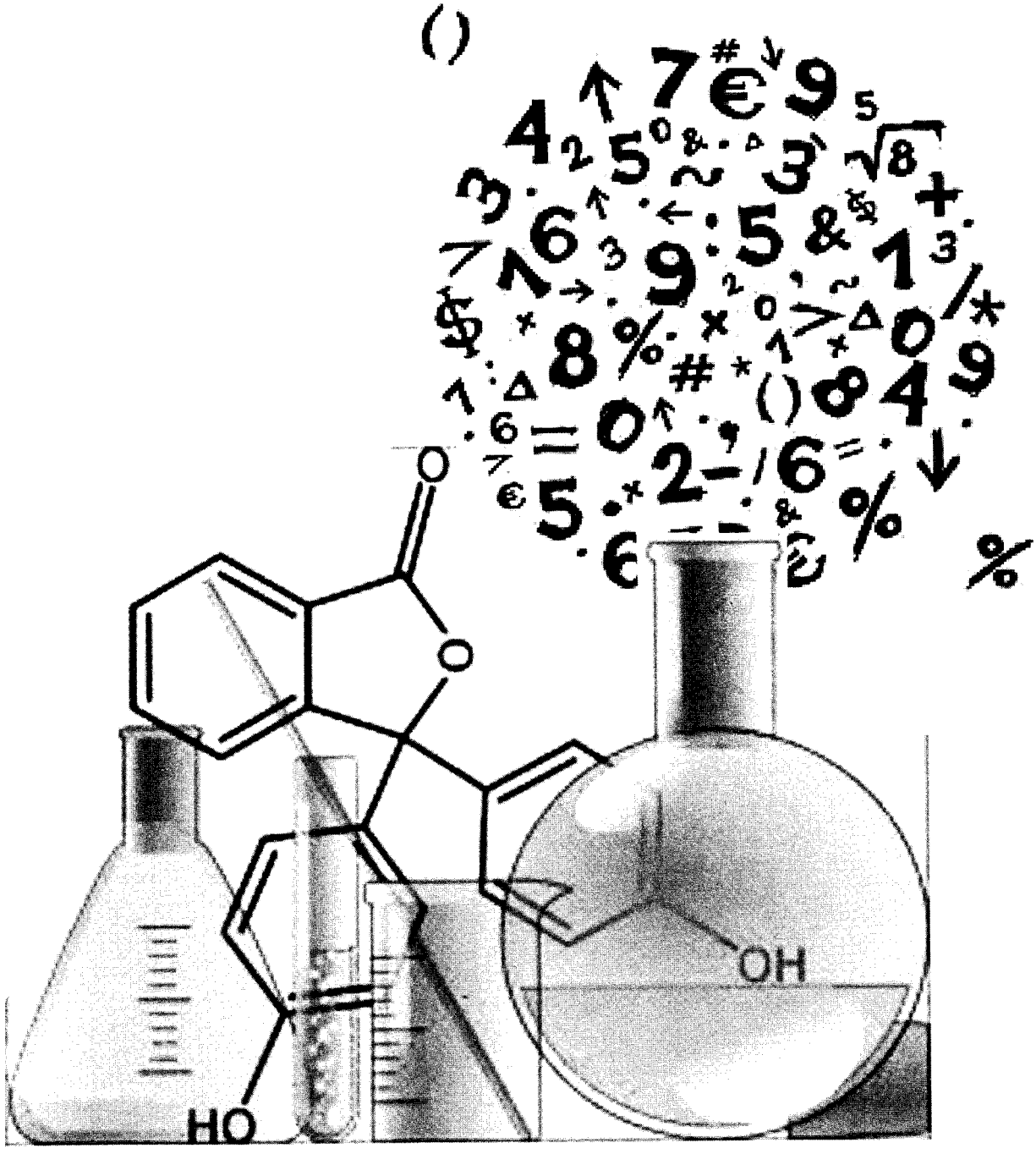

Multiscale Multiphysics Modelling (MMM3) Of Complex Nuclear Systems and the Role of Nuclear Data Science

S. Ganesan
Raja Ramanna Fellow of the DAE
Bhabha Atomic Research Centre,
Trombay, Mumbai-400085 India
Email: ganesan@barc.gov.inGanesan555@gmail.com

Abstract

Indian scientists and engineers at research level in various branches of basic and applied sciences and engineering have not only been intelligent users of handbooks but also generators of new scientific data. However, in many Institutions across India, in the opinion of the author, there is a strong need to introduce and integrate scientific databases and data science, from high school to universities, as part of the Indian educational system. The great importance of big data science in multiphysics multiscale modelling of complex physical systems including error propagations in simulations is well recognized. The modern data science efforts help immensely in eliminating the pitfalls associated with an individual's or individual team's limited efforts to knowledge manage the entire knowledge base related to a specific study/application from microscopic data to integral data. The data science helps to increase system intelligence and system performance. There is a lot of scope for innovative student projects in various topics in data science and in multiphysics, multiscale modelling.

Introduction

Physics as a science is based upon observations, called "scientific experiments" in nature. Science, by definition, does not claim to have found or to be finding the absolute truth. Science, by definition, only claims to be in continuous search of truth. Mathematical modelling of physical events needs quantitative expression of scientific experiments (observations) in the form of numerical scientific data. The voluminous data produced in scientific experiments are thus "signatures" of Goddess of Knowledge, Saraswati. These scientific databases consist of hard core numerical data, in some cases running to hundreds of Gega bytes at raw level, processed level and recommended level and are not to be confused with the traditional and computerized bibliographic databases.

The numerical values of data characterising the physical outcome of events in experiments are the quantitative results of experiments. These numbers are meaningful only if full descriptions of uncertainties in terms of all partial uncertainties and their correlations are specified

by the experimenter. Performing an experiment is costly in terms of equipment and resources of expert manpower and its quality assured and complete documentation including the full numerical data generated is essential to preserve the valuable experience for the benefit of mankind. Data science basically is the art and science of concentrating on compilation, theoretical predictions, study of systematics, computerized handling and visualization, inter-comparison of large databases, evaluation (recommendation of best values) and integral validations at various levels of the physical model. Data science thus includes but goes much beyond the usual qualitative understanding of science and publication of research papers in peer reviewed journals. Such data science or rigorous scientific pursuits were already being done by individual scientists at a personal level or at a team level to seek truth in nature. The modern data science is done by scientific and technical coordination of scientific efforts of a number of teams. These organized data science efforts help immensely in eliminating the pitfalls associated with individual's limited efforts to knowledge manage the entire knowledge base related to a specific study/application from the voluminous microscopic data to integral data. The data science going to unprecedented details of coverage with a high quality assurance helps to increase system intelligence and system performance.

Students in high schools use, for instance, recommended numerical values of physics constants such as, density, specific heat. melting point etc., in calculations. In such instances, they are advised by the faculty to make use of numerical values given in well known hardcopy of available handbooks. Now-a-days, available online sources are recommended for usage of scientific numerical data in teaching and research. The online scientific numerical data recommended for use undergoes continual updating. The scientific and base technology efforts to make recommended data sets starting from "no raw data available" status is three or four orders of magnitude more than the efforts made from the stage of using available recommended data to perform innovative design of complex systems.

General Remarks on Nuclear Data Physics

Nuclear energy is one of the important and viable options to help provide energy security for India, a highly populated and energy deficient country. The human development index is known to considerably improve with increased energy generation and energy management.

"Nuclear data" is a technical term that stands for quantitative results of scientific investigations of the nuclear properties of matter. These numerical data describe quantitatively the physics properties of atomic nuclei and the fundamental physical relationships governing their interactions, thereby characterizing the physical processes underlying all nuclear technologies.

The scope of nuclear data collections includes all 85 natural elements with 290 stable isotopes and more than 2500 radioactive nuclides. There are hundreds of different nuclear and atomic

Physics databases evolved over years of efforts and measurements. The online nuclear data services (http://www-nds.indcentre.org.in) that mirror the nuclear data website of the International Atomic Energy Agency (IAEA), Vienna (http://www-nds.iaea.org) commissioned in Mumbai in November 2004 provide the best recommended data for The user community. Development of knowledge base, providing accurate description of basic nuclear interactions, is a fundamental and natural part of the evolution of nuclear science and technology. As more nuclear physics experiments get done, it becomes imperative to organize the raw data with errors and covariances to be able to correctly analyse, interpret and use for evolving a robust system to perform better basic nuclear physics research. Thus nuclear data science is a front line field that helps in performing better nuclear physics and making accurate application calculations or simulations.

The research in frontier areas of basic nuclear data physics, associated knowledge management and critical evaluation of associated uncertainties are being rigorously sustained, well supported and pursued further in BARC. The existing strength of currently available, state-of-art nuclear databases in use for various applications is highly commendable but inadequate to meet the nuclear data needs of new reactor concepts as different neutron energy spectra, materials and compositions are involved. Ready plug-in nuclear data libraries from international sources are not sufficient to meet all our needs. For technical handling and convenience, The nuclear Data are commonly categorized into two main groups:

1. Nuclear reaction data, describing the interactions of various energetic projectiles such as neutrons, protons or photons with target nuclei, and

2. Nuclear structure and decay data, which provides numerical values of nuclear energy levels, half-lives and radioactive decay radiations.

Obviously, new concepts of reactor designs will have a sound scientific basis if the nuclear data used are accurate.

Applications of nuclear data

Applications of nuclear data include all areas of nuclear science and technology, covering energy applications (fission reactor design; nuclear fuel cycles; nuclear safety; reactor monitoring and fluence determination; waste disposal and transmutation; accelerator driven systems; fusion device design and plasma processing technologies) as well as non-energy applications (cancer radiotherapy; production of radioisotopes for medical and industrial applications; personnel dosimetry and radiation safety; nuclear safeguards; environmental monitoring and clean-up; materials analysis and process control; radiation damage studies; detection of concealed explosives and illegal drugs; exploration for oil and other minerals) and Basic research (e.g. nuclear astrophysics and understanding the origin of the Universe) and education.

The topics in nuclear data physics

The topics in nuclear data physics in India, as presented below, cover a wide range of power

and non-power applications in the Indian context, with a balance of basic and applied nuclear data physics activities by a well-defined team of nuclear physicists, nuclear engineers (that include reactor physicists), mathematicians, radiochemists and software information management. Indian experimental generation of basic physics data. Indian leadership recognizes that experimental studies require good quality research facilities to determine nuclear cross sections covering neutron and charged-particle reactions, and nuclear structure and decay data (all with well-defined uncertainties and to high accuracy), with the ability to cover the nuclear data physics needs for advanced fission and fusion systems (that also has thorium fuel and closed fuel cycle), analytical science and nuclear medicine. This involves, because of the need for neutron sources and particle accelerators, significant costs and capital outlay, and all nuclear physicists by default would provide the expertise to undertake facility Development tailored to nuclear data physics measurements. For the same nuclear reaction, experiments are encouraged to be re-done to re-measure data if better neutron sources of higher intensity and/or better enriched and purer samples and/or better detectors become available. Compilations of nuclear physics data generated by experiments in India and training workshops in EXFOR (Exchange Format (for experimental nuclear reaction data)). This effort requires a deep technical knowledge of nuclear physics to ensure quality in EXFOR compilations. No judgement on quality of the data generated in the experiment is attempted, by design, during this EXFOR compilation process.

- Computerized visualizations of data and uncertainty matrices. Inter-comparisons.
- Large nuclear data files information management, IAEA mirror website (http://www-nds.indcentre.org.in) at Mumbai.
- Evaluations of basic nuclear data which include nuclear model based predictions and generation of covariances. Use of advanced statistical tools is part of this task. As nuclear data physics got importance, the evaluation of nuclear data has been recently started in India but we need to gain A lot of experience before being able to make high quality basic nuclear data evaluations.
- Creating of computerized Indian evaluated nuclear data files in ENDF/B format
- Physics laws based nuclear data processing for multi-group and Monte Carlo applications to produce "plug-in" nuclear data libraries (seen by reactor physicists as the "nuclear data tables". Also, it is well recognized that neutronic Monte Carlo codes can be developed indigenously only when large nuclear data bases such as ENDF/B can be digested and interfaced with Monte Carlo simulations.
- Integral measurements and validations by use of experimental benchmarks and critical facilities. The task involves performing a number of sensitivity studies, assessment of uncertainties in system characterization and benchmarking to match, for instance, the QA of the International Criticality Benchmark Evaluation Project of the US-DOE (http://icsbep.inl.gov).

Multiphysics Multiscale Modelling (MMM3)

The big data science is not just about the matrix of voluminous multi-parameter data generated in experiments. The efforts in data science help to quantitatively model the system with all detailed data and help validation of models at differential and integral levels. This has become possible in the last 2 decades because of rapid improvements in information technology, both computer hardware and software. Also, massive parallelization has added confidence to this initiative. A number of papers and documents are available on the Internet on the topic of multiphysics, multiscale modelling. This topic is relatively a very recent development that is taking place in many branches of science and technology. Attempts to fulfill the long standing requirement that explicitly take into account, when modelling an advanced nuclear reactor system in detail for which the behavior is to be predicted for all processes (neutronic, thermal-hydraulic, structural mechanics of the fuel and other parts, radiation induced damage, burnup evolution, microstructural characteristics such as porosity, cluster size and distribution, grain size,, chemical effects etc.) Simultaneously.
MMM3 is the most complete and detailed form of modelling in 3-dimensions, for a computerized and automatic coupling of various physical processes, such as the following:

- neutronics- of steady state and transients
- thermal-hydraulics of core, full plant, one and two phase flows,
- structural mechanics of the fuel and other parts,
- radiation induced damage, burnup Evolution
- chemical effects etc.

These physical processes extend over large time scales varying from picosecond to decades. Thus a large number of numerical and physical models are employed and validated at various levels with supporting experiments. Sensitivity studies will further identify areas where improvements are needed demanding specific experiments and/or improvement of basic physics data.

The MMM3 makes the full use of all of the relevant knowledge in the form of detailed numerical data quantifying the basic physics processes (such as, for instance, nuclear data in ENDF/B-VII.0 format, thermo-physical data, empirical irradiation damage data, chemical engineering data (e.g., corrosion effects). These physics and engineering databases are large in size and typically run into Gbytes posing challenges in terms of quality assurance to interface them with the codes respecting the physics laws for their condensation in some cases. The use of Monte Carlo codes and parallel algorithms that are viable with current computing power and resources for full core calculations today is helpful in some cases to deal with the structures in the large sized matrix of basic data with consistency. The MMM3 takes into account the strong couplings arising between basic processes of diverse nature over several order of magnitude of time scales. In studies of reactor physics of current and advanced reactors, for instance, strong coupling occurs between structural mechanics, neutronics, and thermalhydraulics. In the area of material science, for instance, in the case of simulation of Reactor Pressure Vessel (RPV) integrity, the motivation is to obtain the integrity limits of RPV in the entire life time of several decades of the operating power. In this case the multiscale multiphysics modelling starts

from a simulation at the most fundamental microscopic atomic scale to simulate quantities such as creation of frenkel pairs, defects migration and evolution, ab-initio molecular dynamics, and dislocation dynamics. These phenomena are tracked over several decades and leads to prediction of change in the strength and integrity of the RPV.

The challenging issue in multiphysics, multiscale modelling is that the correct physics information should pass from one scale to the next with full consistency of the physical laws and with no break in continuity. The multiphysics, multiscale modelling should enable us to "zoom in" on regions that are particularly sensitive to certain parameters.stresses, such as fissures, welds, or supporting structures.

The obvious advantage if one is able to make progress in multiphysics, multiscale modelling is that a number of costly integral experiments that would otherwise require several years to conduct can be significantly reduced. A successful programme of multiphysics, multiscale modelling in current and future nuclear reactors involves a well co-ordinated scientific team work with several disciplines participating over a long term. The culture of the team work to effectively make progress has to be nurtured. The evolution of this strategy also involves fixing a number of basic physics data that goes in the neutronics, thermal hydraulics, radiation damage, chemical changes etc., with reasonable accuracy and performing a large number of coupled sensitivity studies to identify areas and needs of experiments both basic and applied in each of the disciplines.

The resulting design document of a plant using a perfect multiphysics, multiscale modelling is a dream come true for any plant operator. The confidence to take up multiphysics, multiscale modelling In the history of nuclear energy and other areas because of improved computer resources and software developments coupled with the ability to continuously update the basic physics data bases to unprecedented details and accuracy and integral data bases at different integral levels. Many of the effects in operating environment needs extrapolation by theoretical means based upon physics laws from well defined basic integral experiments. For instance, taking the relatively known case of a physics reactor critical facility, one may measure a void reactivity effect at cold temperature in a zero power one-to-one engineering mockup critical facility but verification of the void effect at high burnups at high temperature at normal operation can never be obtained even in such a critical facility but has to be done through reliable modelling and calculations which require a firm scientific basis for extrapolation to operating conditions. Estimation of the scenario and effects of the transient studies for which we may not be able to do an experiment will greatly benefit from a reliable software that performs multiphysics, multiscale modelling.

The multiphysics, multiscale modelling efforts also pose challenges in terms of development Of front-end and post processors and visualization tools and efficient message passing between segments that are coupled. The problem of storage and coupling is demanding. Challenges exist when sensitivity studies are

required to be made in 3-Dimensions and directly compatible with CAD design drawings. Front end techniques such as Computational Fluid Dynamics (CFD) have to be mastered for a variety of problems arising in multiphysics, multiscale modelling. Benchmark experiments have to be going and conducted for each segment and each level of sophistication to bring the efforts to a credible level. For the full scale of MMM3 getting experimental benchmarks is a challenging task.

In the opinion of the author, nuclear energy itself has been introduced to mankind without adequate knowledge of nuclear data physics that would be demanded by advanced reactor designs. This statement on inadequacy of nuclear data may sound strange with hundreds of Gen-I, GEN-II and GEN-III reactors operating today but it must be stressed that the safety and operational requirements of existing nuclear power plants have all been well engineered with a number of one-to-one mockup experiments providing adequate and perceived conservative safety margins.

Basic physics understanding and better data physics of nuclear interactions are continuing to be rigorously sought by nuclear design communities in order to extrapolate to states of the power plant in conditions not covered in one-to-one mock experiments. In the subject area of nuclear data physics, for instance, there is a lot of interest (and challenges) in attempting to quantify nuclear data uncertainties in the form of covariances to enable error propagations to be assessed in complex simulations.

Many aspects of knowledge management are generic and apply across scientific databases in various disciplines. India has been internationally acclaimed by the International Nuclear Reaction Data Centre (NRDC) network for its new managerial initiatives in organizing EXFOR workshops and making, thus far, more than 200 EXFOR entries based upon published Indian nuclear physics experiments. India also joined the ICSBEP criticality benchmarking by contributing experimental criticality reactor benchmarks made in India. India is also participating in the international collaborations of CERN n_TOF programme. These new initiatives which are milestone development activities have indeed provided increased visibility to India's nuclear physics activities in the world in a Highly positive manner. These new nuclear data science activities have been a significant value addition to basic and applied nuclear physics activities in the country.

Concluding Remarks

In this paper, we dealt with some aspects of nuclear data physics requirements with respect to development of advanced and new reactor concepts. India recognizes the need for reliable nuclear data for all evaluations for several hundreds of isotopes/elements in all stages of the nuclear fuel cycle.

Many of the concepts such as "evaluation of basic data", "EXFOR compilations", Integral criticality benchmarking" etc., are new initiatives in India since historically reactor physics studies in India started from the point of using ready "plug-in" (and processed) nuclear data libraries. The Indian nuclear data physics

activities supported by the DAE-BRNS in the last 8 years have expanded considerably beyond this perspective to initiate and include R & D activities on our own nuclear data compilations, evaluation, processing and integral testing. The EXFOR compilation activities are part of classical data physics activities and have made a phenomenally successful start in India. Experimental basic nuclear data physics `measurements using accelerator and reactor based neutron sources in the BARC/DAE and also a programme of critical facility for integral validation of reactor physics data of Advanced Heavy Water Reactor at BARC have been in good progress at BARC.

The nuclear data physics efforts are recognized to be essential in performing better reactor physics studies as part of multiphysics multiscale modelling of advanced reactor design studies. Today, with the exponentially rapid growth of computing resources, parallel computing and algorithms development and with the continuous improvement of basic physics data, a relatively an ambitious R&D approach, called multiphysics, multiscale modelling is being attempted, with confidence, worldwide. The successful benchmarking of many individual codes/physics phenomena against a vastnumber of experiments has added confidence to this initiative.

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A number of colleagues in BARC, IGCAR and in several Universities have contributed to the on-going and successful MMM3 and nuclear data physics efforts mentioned in this article. The author would like to express his sincere thanks to each of them. This article was prepared upon invitationrom Dr. Manabendra N. Bhattacharjee, Head, Department of Chemistry, Shillong College, and Dr. (Mrs.) Betylda Jyrwa of Department of Physics, North Eastern Hill University, Shillong, Meghalaya. The article has been prepared for the Souvenir to be published by Shillong College on the occasion of "GOLDEN JUBILEE OF TEACHING SCIENCE in SHILLONG COLLEGE," 23 to 30 July, 2013. I wish the College all success.

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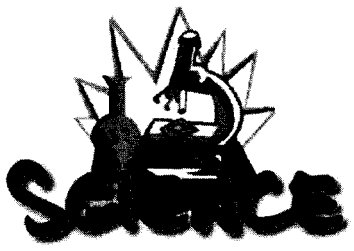
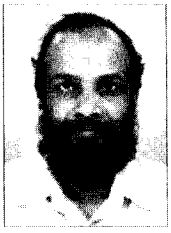


Catalytic Olefin Metathesis: One of the Major Discoveries in Chemistry

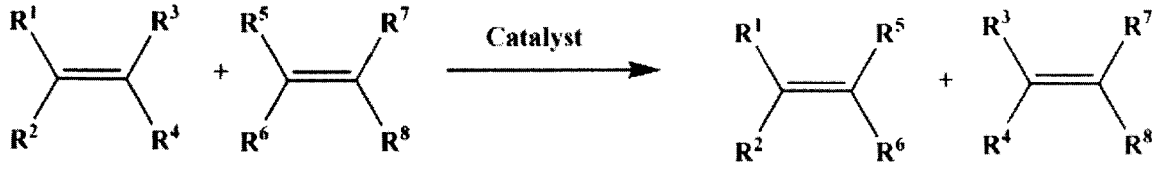
Manish Bhattacharjee
Department of Chemistry, Indian Institute of Technology
Kharagpur 721302, India
Email: mxb@iitkgp.ac.in



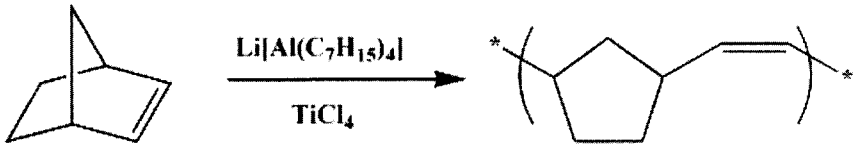
Introduction

Catalytic alkene metathesis is nothing but redistribution of substituents of alkene by bond breaking and regeneration of carbon carbon double bond (Scheme 1) catalyzed by transition metal complexes. This is a very important reaction in modern day chemistry. If one compares with other alternative organic methods for this reaction, it is the most simple and atom economic reaction.

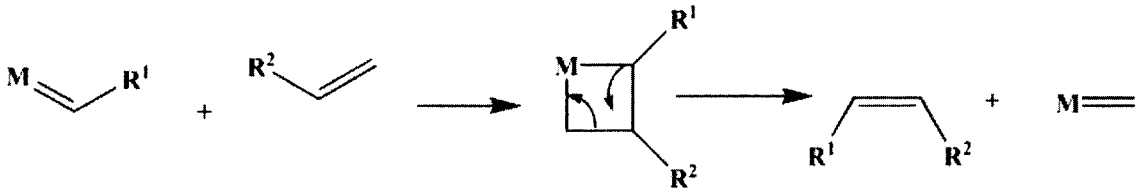
Truett et al. showed that, norbornene can be polymerized to polynorbornene using lithium aluminium teteraheptyl and titanium tetrachloride as catalyst (Scheme 2) and they suggested that, the polymerization proceeds through a coordination polymerization mechanism.1



Scheme 1: Catalytic alkene metathesis



Scheme 2 Polymerization of norbornene



Scheme 3 Mechanism of olefin metathesis proposed by Y. Chauvin

Metal Carbene Complexes

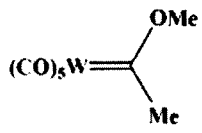
First carbene complex, (CO)5WC(OMe)Me, was discovered by E. O. Fischer in 1964. There are two types of carbene complexes, namely, Fischer carbenes, where metal is in the low oxidation state and the carbene carbon is electrophilic in nature and the second type of complexes are known as Schrock carbenes, synthesized by R. R. Schrock. In Schrock carbene, the metal is in high oxidation state and the carbene carbon is nucleophilic in nature. Some of the examples are given in Chart 1. Another class of carbene complexes of ruthenium has been synthesized by R. H. Grubbs. Carbenes can be considered to be neutral two electron donors.

After the discovery of the olefin metathesis catalysis, this methodology has been used in the field of petroleum industry, polymer industry and in pharmaceutical industry as well as in academia. Yves Chauvin, R. R. Schrock and R. H. Grubbs were awarded Nobel Prize in Chemistry for their contribution in this field.

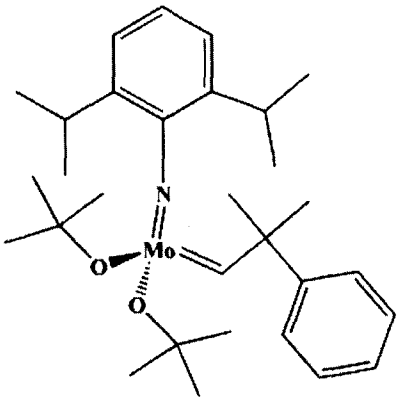
As presented in chart 1, Fischer carbenes are complexes of tungsten(0) and molybdenum(0) and Schrock carbenes, also known as alkylidenes, are complexes of molybdenum(IV) and those of tungsten(IV) and tantalum(IV). Grubb's catalysts are alylidene complexes of ruthenium(II). There is another similar class of complexes, known as vinylidene complexes of the type LnM==CR1R2, where the middle carbon is electrophilic in nature. The synthesis of carbene complexes are simple and a large number of such complexes have been synthesized (Scheme 4).3, 4, 5.

Application

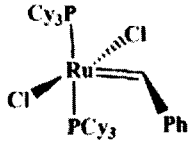
The catalytic olefin metathesis has been used for (i) cross metathesis, (ii) ring closing metathesis (RCM), (iii) ring opening metathesis (ROM), ring closing metathesis (RCM), (iv) ring opening metathesis polymerization (ROMP), (v) enyne metathesis and (vi) acyclic diene metathesis (ADMET). A few important examples are discussed in this article.6



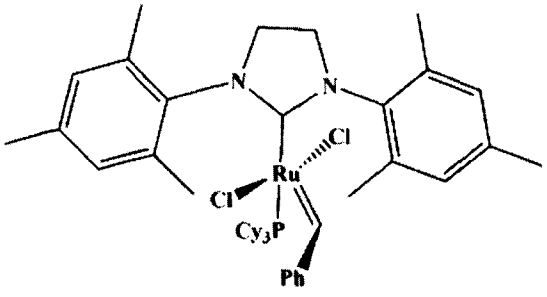
Fischer Carbene



Schrock Carbene

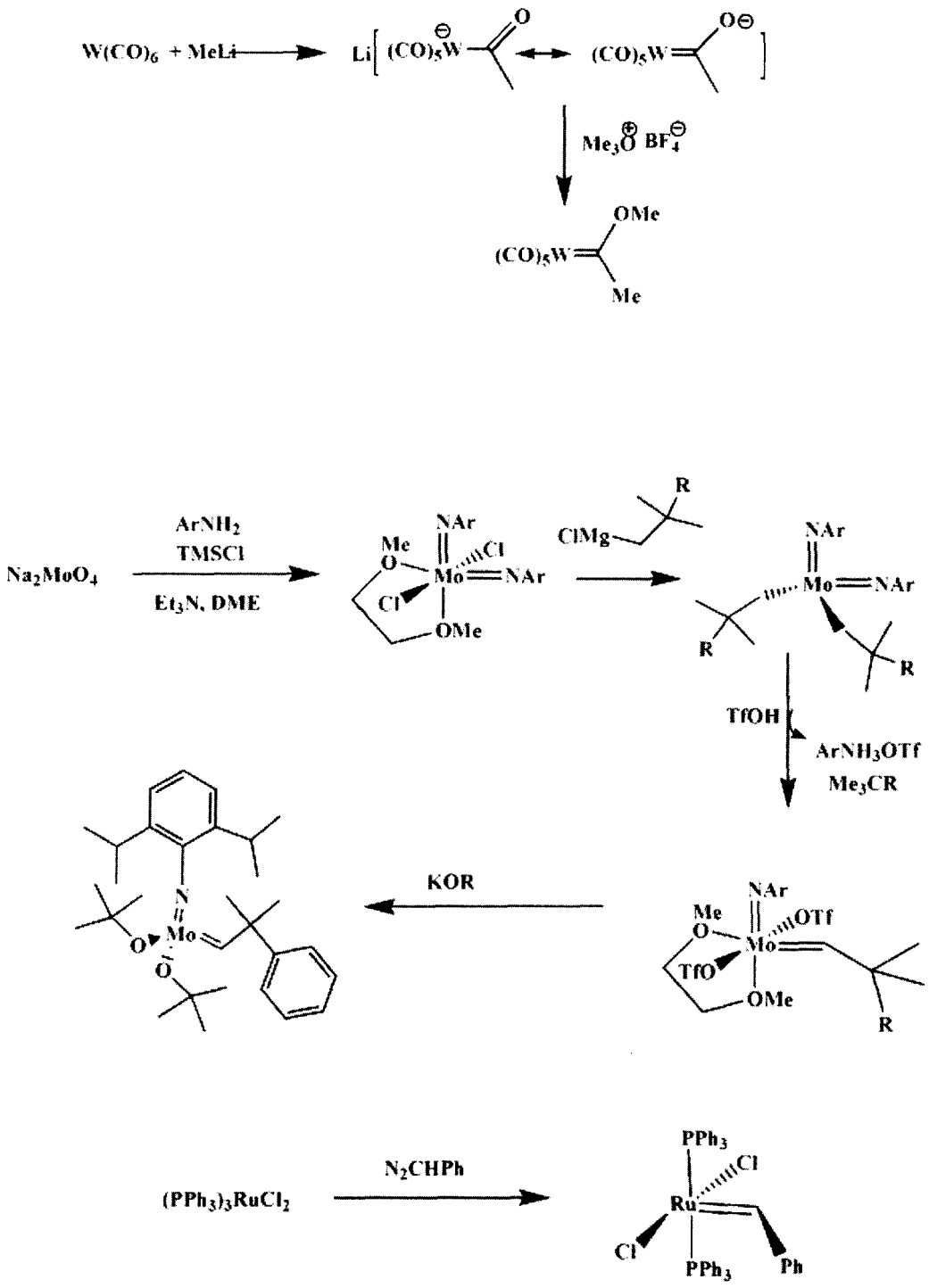


Grubbs' first generation catalyst



Grubbs' second generation catalyst

Chart 1: *Different type of metal carbene complexes*



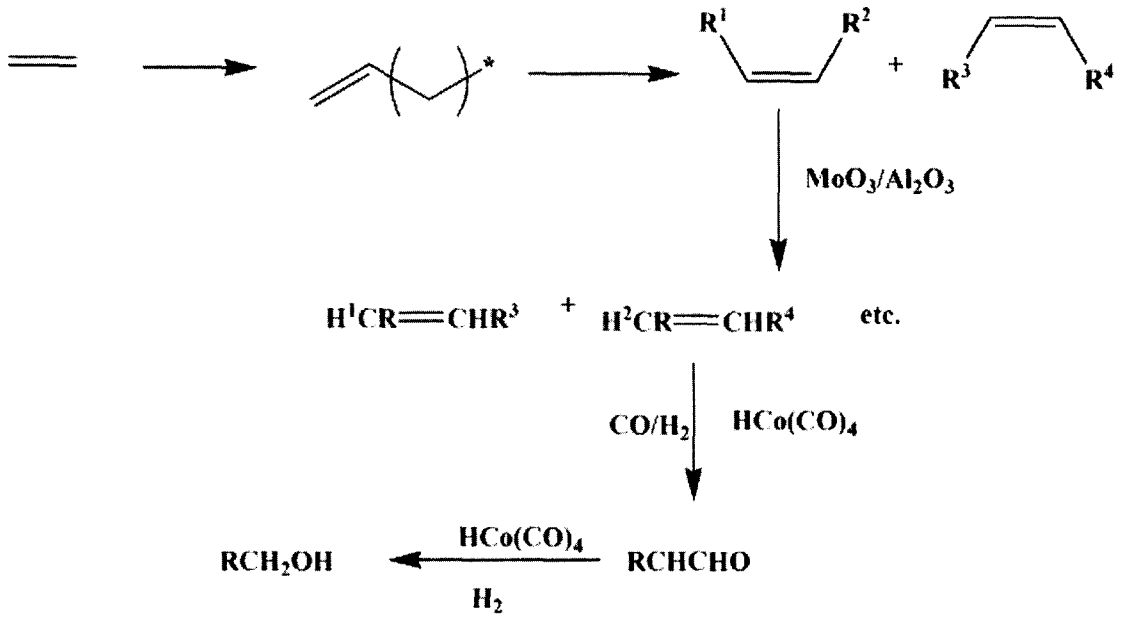
Scheme 4 Synthesis of metal carbene complexes

Cross Metathesis

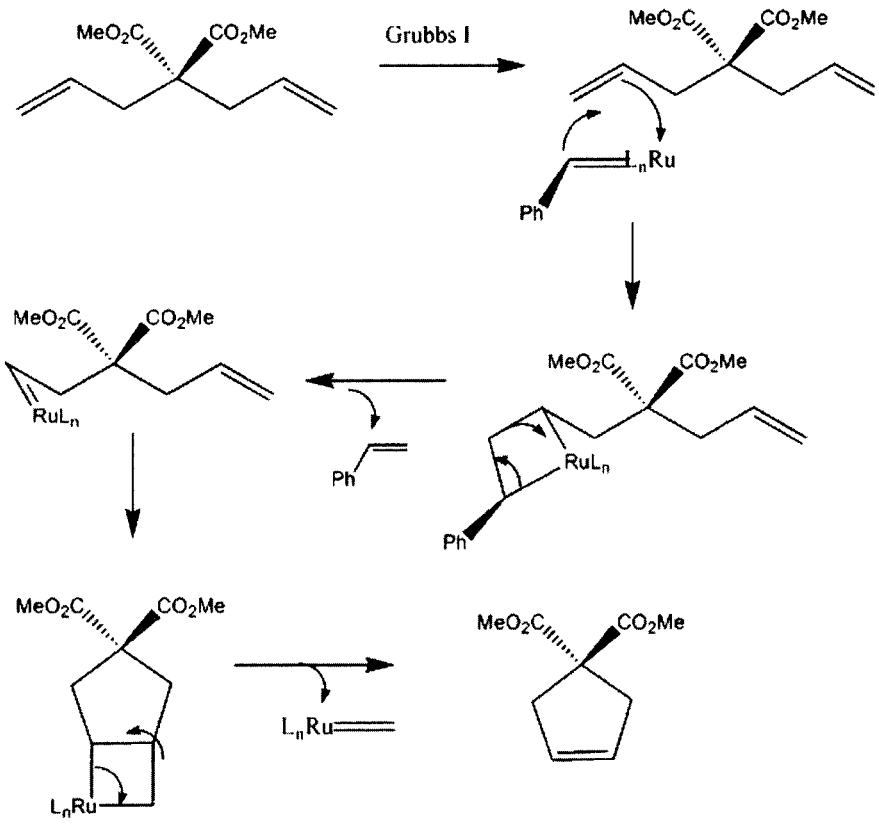
One of the earliest industrial applications of olefin metathesis is the Shell higher olefin process (SHOP). In this process ethylene is oligomerized using nickel catalyst and olefins are separated in to fractions: C4 C8, C10 C18, and C19. The lighter and heavier fractions are isomerized to internal alkene and are subjected to metathesis reaction over a heterogeneous catalytic system consisting of MoO3/Al2O3. The products are internal linear olefins containing 10 18 carbon. These internal olefins are converted to terminal aldehydes using cobalt carbolyl which is reduced to alcohol, which are used as precursors for detergents preparation (Scheme 5).

Ring Closing Metathesis

In ring closing metathesis a diene is converted into five or six membered ring (Scheme 6). Large rings are also synthesized by ring closing metathesis. This reaction is done under high dilution condition. This method has been applied for the synthesis of a large number of natural products and anti cancer drugs. One such example if epothelones (Figure 1).



Scheme 5: Schematic representation of SHOP



Scheme 6 Ring closing metathesis using Grubbs 1st generation catalyst

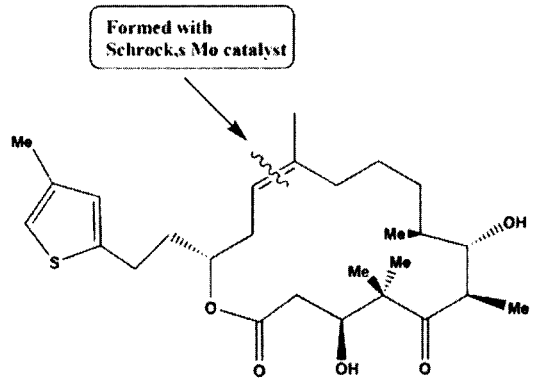
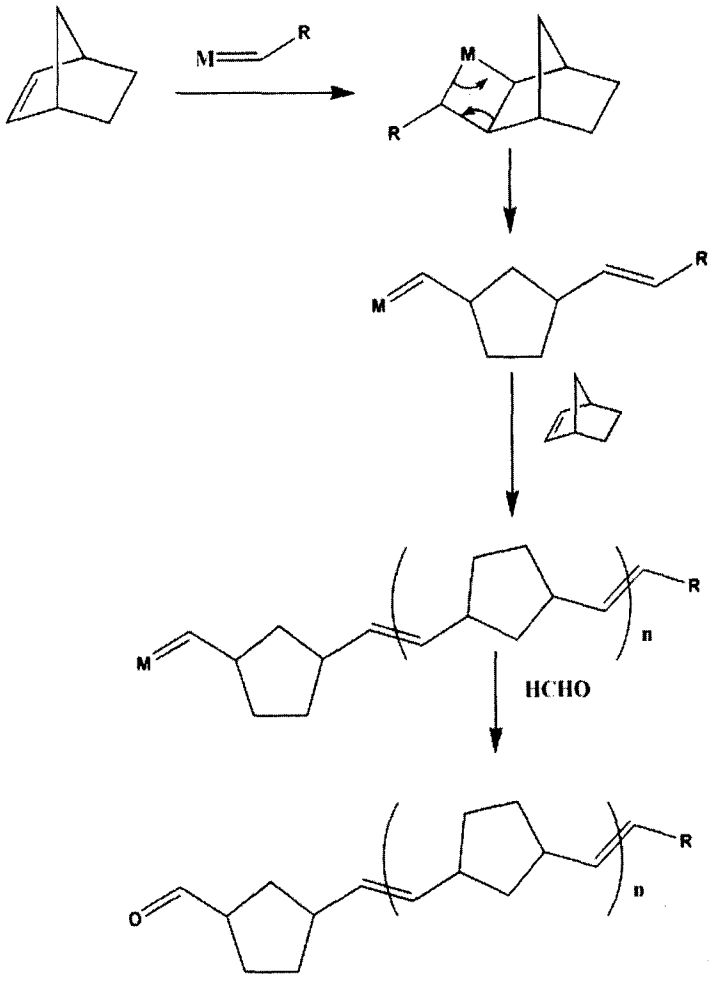


Figure 1 Structure of Epitholine C

Ring Opening Metathesis Polymerization (ROMP)

This process can be used to synthesize polymers having desired properties like hydrophilic, hydrophobic or polymers with pendant functionalities. In this polymerization strained ring system is opened and polymers can be produced (Scheme 7). This process can be used for the synthesis of diblock, or triblock copolymers.



Scheme 7 ROMP of norbornene

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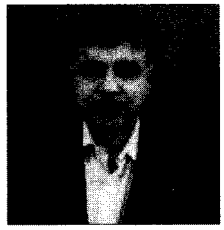
ANCIENT CHEMISTRY AND ALCHEMY

Prof. Kali Prasad Sarma
Department of Environmental Science
Tezpur University, Tezpur, Napaam



Present chemical science is a result of long process of development over 5000 years of history. The ancient chemistry has developed from the practical works of the artisans. The use of fire, about 9000 years1 ago, for making earthenware may be considered as the beginning of chemical science. The first chemical reaction used in a controlled manner was fire and fire was simply a mystical force that could transform one substance into another while producing heat and light. It was fire that led to the discovery of glass and the purification of metals which in turn gave way to the rise of metallurgy. In its beginning, chemistry was probably developed in the hands of the Egyptians crafts-man. These people were highly skilled technicians and they used chemical technique to produce metals from ores, making pottery and glazes, fermenting beer and wine, making pigments for cosmetics and painting, extracting chemicals from plants for medicine and perfume, making cheese, dying cloth, tanning leather, rendering fat into soap, making glass, and making alloys like bronze without knowing the principle of chemical science. The tomb painting and tomb culture, which is still persisting, furnished many evidences of the ancient history of chemical art and experiments. These peoples who have such skill were mostly physicians or as followers of a religious tradition had objectives, how to cure a variety of illnesses. However, in the beginning of the Christian era, these chemical philosophers tried to rationalize the art of technicians with certain principle which were influenced by religious magical ideas. These philosophers were known as alchemist. In the history of chemistry, alchemy refers to both an early form of the investigation of nature and an early philosophical and spiritual discipline and was practiced in Mesopotamia, Ancient Egypt, Persia, India, Japan, Korea and China, in Classical Greece and Rome, in the Muslim civilizations, and then in Europe. Up to 16th century, alchemy was considered as serious science in Europe. In this article an attempt was made to highlight some of the aspects of the work of ancient skilled technicians and alchemist to see how they contributed towards the development of modern chemical science.

Development of Early Chemistry

Around 3000 BC the metal workers of Mesopotamia

learned how to make bronze by mixing tin and copper. They would melt the metal at very high temperatures and then poor it into moulds to make all sorts of items including tools, weapons, and sculptures. The use of metal was necessitated to achieve some of the day-to-day requirement of ancient people, was a great achievement in man's early history. Even as early as 3400 BC the Egyptian had an intimate knowledge about the process of extraction of metal from its ore. There was a close relation between priests of the Egyptian royal family and the development of Science. Traditionally, chemistry was first developed in the laboratory of Egyptian priests. The original impetus of working of metal may have come from the fact that the metal tools are far more durable than bone, stone and clay. People at that time were familiar with the native gold, silver, copper and iron, as these were naturally available in the sand of some river. But it is still a mystery for us how the ancient people were able to accomplish the reduction of metallic ore as early as 3000-4000 B.C. The Egyptian first extracted copper by adopting a carbon reduction method from malachite ore in the peninsula of Sinai that dates back to 3400 B.C2. The reduction of copper from its ore was the first metallurgical operation that was learnt by men. They probably acquired the knowledge of reduction of ore by imitating the natural reduction process that was occurring in forest fire. Similarly, bronze was made directly by reducing a mixture of ore containing both copper and tin. The chemical analysis of the old copper objects done by Prof. J. Sebelian3 showed that in most of the countries excepting Egypt and Mesopotamia, these were made of both copper and tin. In India also bronze implements of early date have been found along with those of copper4. This proves that in trying to prepare copper they also produced bronze. Iron Age followed the Bronze Age. Iron is the third metal in succession where carbon reduction of method was adopted.

The method of reduction of iron oxide was an elaborate process and required sufficiently high temperature. This may be the reason behind the late development of iron metallurgy. Similarly, Palestinian sites dating back to 1200 BC in fact obtained brass from a mixture of copper and zinc containing ore2. Mercury was known to the Egyptian at 1500 BC and the ancient Hindu and Chinese literatures also show reference to this element. Probably, Indians first knew extraction of zinc and silver from its ore5,6. Besides extraction and use of metals ancient people also knew the art of making coloured and glazed pottery that had started before 3000 B.C. in Mesopotamia. The alkali used in its manufacture was natron. The colouring was achieved by using various metallic oxides.

Mercury, the liquid metal, certainly known before 300 BC. Mercury united with most of the other metals, and the amalgam formed colored sulfide powders when treated with sulfur. Mercury itself occurs in nature in a red sulfide, cinnabar, which can also be made artificially.

Glass making was one of the most important art practiced with noticeable success by the ancient crafts-man. Archaeological evidence suggests that the first true glass was made in coastal north Syria, Mesopotamia or Ancient

Egypt1.The earliest known glass objects, of the mid third millennium BCE, were beads, perhaps initially created as accidental by-products of metal-working (slags) or during the production of faience, a pre-glass vitreous material made by a process similar to glazing. The glass jars and ornaments discovered in the tombs show that these items were produced on large scale from a very early date. The fine coloured glass beads contained copper compounds2 was known to Egyptians as early as 4000 BC. Infact pottery and glass manufacturing was the beginning of early chemistry. It appears that a glass formulation with a formula relatively similar to that of modern glass had been obtained and utilized with widespread familiarity by the second millennium BC. Examination of ancient glass articles show that it was a soda lime glass. They put different substance for colouring those articles and lead was used in glass from very ancient times. Potash and soda are also used in production of glass. It is noticeable that the chemical compositions of ancient glass are relatively similar to those of the modern era. The compositions of early glasses are soda-lime-silica and potash-lime-silica glasses with sodium oxide providing the flux and calcium oxide the stabilizer. The major chemical constituents of glass are silica or sand (SiO2), sodium oxide (Na2O) or potassium oxide (K2O) as a fluxing or alkali agent that reduces the melting temperature of silica, and calcium oxide (CaO) from lime. Perfumes have been a very important culture since ancient times. Many perfume containers have been found in tombs.

Among the list of other substances used by the ancient people are beer, alcohol and bread 7, 8. Chemical tests of ancient pottery jars reveal that beer was produced about 7,000 years ago in Iran where the biological process of fermentation is used in a process. These substances were very important items of diet from the prehistoric times9. It would however, be difficult to give exact chronological order of discovery and its method of preparation. The use of earthenware, which could have possibly helped men to observe the chemical changes that, took place (fermentation) in some sugar-containing liquid. Such fermentation process was a mere coincidence rather than an intention. People were unaware about the fermentation or about the air-borne yeast. But they knew the art of converting sugar-containing liquid to alcohol by adding the necessary zymase form their saliva. Similarly, the ancient people were familiar with the art of making both leavened and unleavened bread and used yeast at a very early date. Ancient Egyptians are believed to be the first to have baked leavened bread. In 3,000 B.C., they started fermenting a flour and water mixture by using wild yeast, which was present in the air. Loaves and rolls have been found in Egyptian tombs dating to 5,000 years ago.

Studies made by archaeologist on porous bread found in tombs show the presence of dead yeast cells. Yeast decomposes sugar - containing substances, producing alcohol and carbon dioxide, which is clearly a chemical process. There are various types of paintings in the tombs of making wine, bear and bread. On the other hand different types of dye were used for paintings tombs and caves. These paintings are still remaining bright (for e.g. painting of the

caves of Trois Ferris in the Ariege district of southern France). However, the beginning of the art of dyeing is lost in antiquity. Dyeing of Mummy's cloths, which are preserved in many museums, is the evidence of the art of ancient dyer's skill. The chemical analysis of the substances from painted walls of tomb, decorated surface of pottery is able to give us knowledge of the materials used for such purposes It was found that the red pigment proved to be iron oxide (haematite), a yellow consisted of clay containing iron, pale blue was a copper carbonate, green were malachite, black was charcoal, grey, a limestone mixed with charcoal etc. This clearly shows the ingenuity of the ancient people in transforming one substance to another and the antiquity of chemistry. The use of blue dye indigo in ancient civilization was a highly skilled process and much admired by all because of its superior beauty and remarkable durability. Egyptians obtained the dye from indigo plant more than 4000 years ago10. They dyed all kinds of fabrics. The dyeing of fabrics with indigo needs considerable exacting chemical manipulation. The freshly cut plants were allowed to ferment with water to decompose the glycoside (indicant) into glucose and indoxyl (indigo white). In dyeing, indigo is reduced to the soluble leuco form. The fabrics are then immersed in this solution and exposed to the air, when the indigo white is oxidized into blue indigo. Although, the exact method and the chemicals used by the ancient people are not known yet they must have known the process of reduction. Various types of natural dyes were applied to cotton with the help of a mordant. Pliny2 describes a process of dyeing the fabric with the aid of metallic compound such as alum and salts of iron, copper and tin. Pliny also describes a process of obtaining a polish by the ancient Egyptians by heating a mixture of copper one-third part, silver one part and sulphur one part11. Moreover, the early Egyptians smeared black or green pigments around their eyes as is known from the predynestic graves. The green pigments were malachite and black pigments were made from lead sulphide or antimony sulphide, copper oxide and manganese dioxide. Egyptian blue is a synthetic blue pigment, also known as calcium copper silicate ($CaCuSi_4O_{10}$ or $CaOCuO_4SiO_2$), is a pigment used by Egyptians for thousands of years. It is considered to be the first synthetic pigment.

The ancient people especially in Egypt, Arabia, India, China and Mesopotamia used ink, which has retained its colour to present. Most of the black inks contain carbon and the Ebers papyrus. Red ink has been found to contain lead. This was commonly used as pigments in painting. All these ideas of transforming one material to another (sometimes a new one) were of enormous importance in enlarging the tanner's knowledge of physical and chemical properties of matters and this knowledge helped then to tan skins into very fine leather with the help of vegetable extractives.

The use of medicines for combating diseases is very old. Indian Ayurvedic medicine is quite ancient. Most of the natural drugs require either no chemical treatment or at most only pharmaceutical manipulation before use. Besides herbal drugs Indian materiamedica

consists of few minerals like mercury, sulphur, arsenic, lead, copper, and gold for remedies of various diseases. However, in the preparation of few drugs such as alum, bread, beer, charcoal, copper, verdigris, vinegar, wine involved chemical reactions and ancient people knew the art of preparing all these. The Egyptians Priests knew the method of preparation of hydrocyanic acid which was known to them as "penalty of death"12.

Arabian medicines had a much closer relations with chemistry. Many of the modern medicines now in use are of Arab origin.

Chemistry and Alchemy

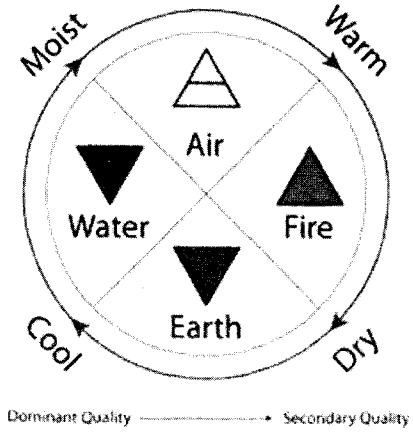
The Science of chemistry is often described as growing out of a pseudo-science called alchemy. The word alchemy either may have originated from, Egyptian kemi black, means the art of treating 'black metal' to produce precious metals or from the Greek khymeia, 'fusion', i.e. the art of melting gold and silver. It is an early form of philosophical and spiritual study of nature. They investigated elements of chemistry, metallurgy, physics, medicine, astrology, mysticism, and spiritualism. The early alchemy was essentially a craft and embraced many kinds of metal works. Alchemy has been practiced in Mesopotamia, Ancient Egypt, Persia, India, and China, in Classical Greece and Rome, in Arbia, and then in Europe up to the 19th century. Alexandria is generally considered a center of early alchemy and their art was influenced by the philosophy of the Hellenistic Greeks. It is believed that alchemy was first practiced in Egypt and it arose in China in 5th or 3rd century BC. The grand object of the alchemical art was the discovery of a process by which the baser metals might be transmuted into gold and silver. The transmutation of base metal into gold was to be accomplished by the application of powder, stone or elixir an imaginary substance thought to be capable of restoring youth to aged - a remedy that supposedly would cure all diseases and prolong life indefinitely. The substance was often termed as philosopher stone. From the religious point of view, the transmutation of metals can be thought of as a symbol of the transmutation of the self to a higher consciousness . The alchemists were also interested in finding the elixir of life which would cure all ailments and enable people to live forever. They believed that, by spiritual processes akin to those of the chemical processes of alchemy, the soul of man may be purified. Ancient Egyptians considered alchemy as the study of hidden wisdom or truth-that existed beneath the surface. Alchemists never had the inclination to separate the physical /chemical aspects of their craft from the metaphysical interpretations.

Since early alchemists were mainly artisans they tried to conceal the secrets of their works. In the early modern period a variety of laboratory procedures viz separation of metals, sublimations and distillations were described in alchemical terms and they were associated with preparing medicine. They carried out experiments chiefly with Metals and other materials At that time the gold was considered the most perfect of metal and its efforts of conversion was a part of a general striving of all things towards perfection. In some epochs and contexts, these metaphysical aspects came to predominate, and the chemical processes were then viewed as mere symbols of spiritual processes.

Alchemy has always made extensive use of comparison, symbolism to relate chemical and physical concepts to obscure and spiritual ones and imaginary relation was developed among the metals and sun and plants (Gold -- The sun; silver The Moon; Electrum The Jupiter; Iron Mars; CopperVenus; Tin Mercury; Lead Saturn).

Aristotle (384-322 BC), whose scientific ideas dominated the entire medieval science, proposed that matter was composed of four elements earth, air, fire, and water - which in varying proportions constituted all things. Modern chemistry developed out of medieval alchemy. None of these are the same as the Atomic Elements of modern science, but rather represent the basic symbolic correspondences of the universe. The qualities are: hot, cold, wet, dry (Fig-1). The qualities define the character of "elements". Fire was seen as ideal mixture of hotness & dryness. One element could be changed into another like mixing solutions.

Fig.1: Four Aristotelian elements: Fig shows how the elements and their qualities are arranged and related.



Isaac Newton worked intensively devoting considerably more of his time and writing to the study of alchemy. Other eminent alchemists of the Western world are Roger Bacon, Saint Thomas Aquinas, Tycho Brahe, Thomas Browne, and Parmigianino.

Boyle also studied the alchemical art but he never believe alchemists' tradition of secrecy Boyle also studied the alchemical art but he never tried to conceal his experimental findings. He always insisted on publishing the details of his work, including the unsuccessful experiments. He also attempted to transmute a base metal into a noble metal. But he was not successful in his endeavour. The decline of alchemy began in the 18th century with the birth of modern chemistry, which provided a more precise and reliable framework for matter transmutations.

The goal of alchemy i.e. transmutation of matter, came into reality in the 20th century when physicists were able to convert lead atoms into gold atoms via a nuclear reaction. Soddy was the man who quickly made a connection between the ancient search for the philosopher's stone and the nuclear transformation.

Conclusion

It is evident from the above discussions that people started making keen observations on properties of matter from the end of Palaeolithic age. They were acquainted with at least nine of the Chemical elements (such as gold, copper, silver, lead, iron, tin, mercury, sulphur and carbon) and some chemical substances before the rise of alchemy. Notwithstanding, this fact it would be myopic to ramify ancient practical

knowledge as chemical science as these were not based on certain chemical principles. Though the alchemists did invent some of the glassware and other laboratory equipment still in use today, modern chemistry did not begin with the alchemists.

The people who made such contributions never thought of themselves as chemists. They acquired this intensive and varied knowledge by imitating natural phenomenon which has resulted in the development of practical aspects of chemistry and their contributions were inseparable parts of their cultural life.

To know the history of science in general and chemistry in particular one has to study the ancient art and alchemical science as it is considered as the main precursors of modern sciences and many substances and processes of ancient alchemy continue to be the mainstay of modern chemical and metallurgical industries. Sometimes it is claimed that the alchemy of the Middle Ages developed into modern chemistry. Though the alchemists did invent some of the glassware and other laboratory equipment still in use today, modern chemistry did not begin with the alchemists. Modern chemistry did not begin its development until scientists had rejected the futile teachings of alchemy. Robert Boyle rejected the superstitions of alchemy and published The SkepticalChymist, in which he described alchemical fallacie.

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Particle Therapy : A boon for cancer patients

By B. Jyrwa
Nuclear Physicists Physics Department NEHU
Shillong:793022, Meghalaya
Bjyrwa@gmail.com

Introduction

Recent trends reveal that the number of cancer cases is growing exponentially. Conservative treatment like radiation therapy (x-rays and □ rays) have not been very effective especially for deeply seated tumours. The solution lies in particle therapy technique which has been established to be quite successful coupled with minimal side effects. This is one of the many applications of nuclear physics with respect to its enormous impact on the treatment of cancer , herein lies the need for taking up Basic Sciences courses in order to circumvent the untold miseries facing mankind.

Description

Proton therapy, like all forms of radiotherapy, works on the principle of shooting energetic protons accelerated with an accelerator onto the target tumor. These particles damage the DNA of cells, ultimately causing their death. Cancerous Cells, because of their high division rate and their reduced ability to repair damaged DNA, are particularly vulnerable to attack on their DNA. Due to their relatively enormous size, protons scatter less easily in the tissue and there is very little lateral dispersion, the beam stays focused on the tumor shape without much lateral damage to surrounding tissue. All protons of a given energy have a certain range; no proton penetrates beyond that distance. Furthermore, the dosage to tissue is maximum as evident from the Bragg peak(fig:1). This is depth depends on the energy to which the particles were accelerated by the proton accelerator, which can be adjusted to the maximum rating of the accelerator. It is therefore possible to focus the cell damage due to the proton beam at the very depth in the tissues where the tumor is situated; tissues situated before the Bragg peak receive some reduced dose, and tissues situated after the peak receive none.

History and development

In 1945 William Housen developed a linear accelerator that produced 4.5MeV electrons. He had aimed to advance research in nuclear physics, but little did he know was that his invention was to have an enormous impact on medicine. Simultaneously Robert R. Wilson explained the narrow Bragg peak Fig(1)and publishing his famous paper in the journal

Radiology where mention was made on the use of protons (carbon ions) to irradiate tumors while sparing the healthy tissue traversed, contiguous and located more deeply. But the idea could not be accepted by the medical communities. It took almost a decade before Berkeley and Harvard treated patients with proton beams for accelerators designed for nuclear-physics experiment. Then finally in 1990 Oncologists began to realize the therapeutic use of this new method, because of the size of the apparatus was huge by medical standards and irradiation was carried out in nuclear physics lab. Basically one uses horizontal particle beams and simple beamshaping methods. In 1993 around 10,000 patients on global platform were treated with protons and by 2006 this number increased five fold.

Way back in 1961, radiotherapists at Massachusetts General Hospital collaborated with physicists from Harvard in treating thousands of patients with head and neck tumors(fig 3). A majority of the cases proved successful methods. In 1993 the Luma Linda University Medical Centre at California set up a 1st dedicated proton synchrotron meant only for proton therapy whereby patients are irradiated in 3 treatment rooms each having magnet beam lines on 10m high gantries (fig:-4)which rotate around the patient. Basically the energy of the protons is 200 MeV is used to reach deep-seated tumors. The method used in proton therapy as mentioned above generally does not impart high doses. One can also use the technique for treating Lung Cancer with 4D Protons compared to the x rays traditionally used in radiation therapy, protons offer the potential to destroy lung tumors just as competently while inflicting less damage to surrounding healthy tissue. In traditional radiation therapy, one must use multiple beams of x rays to deliver a uniform dose to a lung tumor; often at least one of the x-ray beams will exit from the healthy (non-tumor-containing) lung and potentially damage it. On the other hand, positively charged, subatomic protons only travel a limited distance through the body; they never make it to the other lung, and they also are more likely to spare nearby organs such as the esophagus and heart.collaborated with physicists from Harvard in treating thousands of patients with head and neck tumors(fig 3). A majority of the cases proved successful methods. In 1993 the Luma Linda University Medical Centre at California set up a 1st dedicated proton synchrotron meant only for proton therapy whereby patients are irradiated in 3 treatment rooms each having magnet beam lines on 10m high gantries (fig:-4)which rotate around the patient. Basically the energy of the protons is 200 MeV is used to reach deep-seated tumors. The method used in proton therapy as mentioned above generally does not impart high doses. One can also use the technique for treating Lung Cancer with 4D Protons compared to the x rays traditionally used in radiation therapy, protons offer the potential to destroy lung tumors just as competently while inflicting less damage to surrounding healthy tissue. In traditional radiation therapy, one must use multiple beams of x rays to deliver a uniform dose to a lung tumor; often at least one of the x-ray beams will exit from the healthy (non-tumor-containing) lung and potentially damage it. On the other hand, positively charged, subatomic protons only travel a limited distance through the body; they never make it to the other lung,

and they also are more likely to spare nearby organs such as the esophagus and heart.

However, the protons' finite range makes their trajectories particularly sensitive to density changes in the lung, caused, for example, by the expansion of the lung during inhalation. For that reason, if the proton treatment is not carefully planned, there is the chance of missing the tumor, thus decreasing the chance of curing the patient. So in planning the treatment of lung cancer patients, the researchers adopted the 4D approach, which is already used in traditional x-ray cancer therapy. Since 1980, a large programme of systematic studies (relative biological effectiveness) of RBE had been carried out at various accelerators e.g. Unilac & SIS at Darnstadt, Ganil (Caen), Bevalac (Berkeley) and the Tanden Van de Graff (Heidelberg). The objective of these studies was to probe the effects on very different biological objects from cellular systems such as DNA and chromosomes, to biological systems that are resistant to extreme environmental conditions.

Carbon Ions

More than a lakh biological samples have been irradiated for a variety of ion beams. The results from such an investigation revealed the capacity of cells to repair DNA damage which is a very important factor. The work showed that for beams of C ions the section of the particle track with increased RBE fits with a few cms up to theProton treatment is not carefully planned, there is the chance of missing the tumor, thus decreasing the chance of curing the patient. So in planning the treatment of lung cancer patients, the researchers adopted the 4D approach, which is already used in traditional x-ray cancer therapy. Since 1980, a large programme of systematic studies (relative biological effectiveness) of RBE had been carried out at various accelerators e.g. Unilac & SIS at Darnstadt, Ganil (Caen), Bevalac (Berkeley) and the Tanden Van de Graff (Heidelberg). The objective of these studies was to probe the effects on very different biological objects from cellular systems such as DNA and chromosomes, to biological systems that are resistant to extreme environmental conditions. Carbon Ions more than a lakh biological samples have been irradiated for a variety of ion beams. The results from such an investigation revealed the capacity of cells to repair DNA damage which is a very important factor. The work showed that for beams of C ions the section of the particle track with increased RBE fits with a few cms up to the Bragg peak,(fig :-2) while for lighter ions it is just a few mms. In 1994 the synchrotron facility at the Heavy Ion Medical accelerator in Chiba Japan treated the to healthy tissue to healthy tissues by rotating the beam around the patient so side effects are minimized. Perhaps such complicated hi-tech systems could not be made to run efficiently if it was not for years of understanding colliding particles, in the sub atomic world. Recent techniques in the field of accelerator engineering , treatment planning , beam delivery and tumour visualization have encouraged the need of transferring particle radiation therapy from the lab to the clinic. Heavier ions than protons, such as laser Ar were used for the first time at Berkely in 1957 and 1975 respectively. 2800 received treatment for brain tumor with a Carbon ion beam from a 184 inch cyclotron on the first patient. For deep seated tumors, 4,800 MeV is needed for Carbon ions. By 2006, around 2,200 patients were treated with Carbon ions. The advantage of using Carbon ions was based on the clinical results from Japan, Germany on head,(fig:-3) lung, liver and prostrate tumours which corroborated radiological

predictions on large RBE. In other words the treatment had little or no side effects. In addition there were clear cut indications that Carbon ion beams should be used for deep seated seated tumors which are radioresistant to high energy photons and protons. From all types of ion species , Carbon ions are the most balanced , optimal properties with respect to dose localization in the body. For cancer radiotherapy we require ions/particles of high biological effectiveness which varies proportionally with depth, and Carbon ions are found to be ideal. At HIT in Germany, there had been 90% success of 400 patients treated with Carbon -ions. In Italy, France, Austria and China were 7,000 patients were treated by heavy ion facilities. The cost for such type of treatment is of the order of 10,000 euros for lung cancer with carbon ion, while for head and neck tumors it may cost upto 39,610 euros. , to tailor the dose to the tumour. Hence the charges are astronomical by average Indian standards. In principle a patient can be treated in 510 sessions, reducing both psychological and financial cost. A proton treatment costs 23 times more than a conventional treatment, averaging in the West around 8000 Euros, but the economy of carbon treatment is different because the shortening of the treatment allows for effective use of the infrastructures. In addition, having littleor no side effects reinforces the necessity of active beamdelivery systems for carbon ions. In our country the situation is dismal we have a remarkable gap between needs and resources. It is a mixture of the richest and the poorest. While efforts are made to provide basic radiotherapy facilities, we are yet to set up the technology needed for particle therapy. We require enthusiastic youngsters who will take up basic science research like Nuclear Physics experiment, health physicists and Radiochemists, besides trained technicians and specialists, who can co-ordinate together to help in setting up such facilities which will be a blessing to our fellow country men. Keeping this objective in mind , we realize the necessity to extol and encourage the young generation to pursue Basic Science courses after class XII. In fact there are several incentives besides special scholarships offered by ONGC to meritorious students , we also have fellowships to the tune of Rs16,000/-PM, for research scholars in Basic Sciences. Other avenues are DST, BRNS, and several allied organizations .After class XII. In fact there are several incentives besides special scholarships offered by ONGC to meritorious students , we also have fellowships to the tune of Rs16,000/-PM, for research scholars in Basic Sciences. Other avenues are DST, BRNS, and several allied organizations

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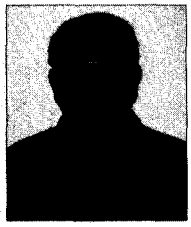
"CSIR- National Metallurgical Laboratory, Jamshedpur- In the service of the Nation"

By Dr. N.G. Goswami,
Chief Scientist and Head,
Information Management and Dissemination Centre,
CSIR- National Metallurgical Laboratory, Jamshedpur, 831 007.



The foundation stone for the National Metallurgical laboratory was laid by Hon'ble Sri C. Rajagopalachari on the 21st November of 1946. It was formally inaugurated and dedicated to the nation on the 26th of November 1950 by Pandit Jawaharlal Nehru "in a spirit of hope and in a spirit of faith in the future." The laboratory formed part of the great plan, which Sir Shanti Swarup Bhatnagar visualized in 1940, for providing India with a network of research institutions capable of taking the country forward in science and technology. The establishment of the laboratory was generously supported, in cash and kind, by the Tata Industries Limited, Sir Ratan Tata Trust and Sardar Bahadur Sir Indra Singh of Indian Steel and Wire Products Co., several distinguished metallurgists from abroad guided the destinies of the newly established laboratory in its formative years. Dr. Bal Raj Nijhawan, the first Indian Director of the laboratory, set the pace for the rapid growth of the laboratory through the establishment of a number of pilot plants and facilities and initiating research programmes which were in line with the Five Year Plans of the young Republic of India. In due course, the laboratory established field stations at Howrah, Batala and Ahmedabad for addressing the problems of the local foundry industry. It also initiated research on marine corrosion through the establishment of a Marine Corrosion Research Station at Digha and extended its reach to the south through the laboratory's Centre at Chennai. However, in the recent time, other than Chennai Centre, rest of the field stations has been withdrawn.

Studies on Archaeometallurgy

It is well established that West Bengal and Bihar independently contributed to the introduction of iron to the subcontinent. These regions were well endowed with rich deposits of copper and iron ores. The iron age dated back to chalcolithic period and the era of 1050-950 BC has been considered to be Ferro-Chalcolithic age. Bahiri, Hatikira, Mangalkot, Pandu Rajar Dhibi in West Bengal and Barudih in Bihar have yielded a large number of iron artifacts and samples of ores and slags. The tradition of smelting iron continues to this day in some the regions. NML Scientists collected samples from the present day Adivasi iron makers and has used these for a comparative study. Studies at

NML were mainly focused on the microstructural aspects of the Hadu/Bishnupur iron. Some attempts were also made in the laboratory towards modifications to the traditional furnace with a view to employ low grade coke as a fuel.

Contribution of NML to the Development of Modern Indian Iron and Steel Industry

Since it's inception NML has been constantly endeavouring to provide essential research inputs to the steel sector. In the formative years of the laboratory as well as the industry, efforts were essentially directed towards the establishment of pilot facilities for the beneficiation of raw materials as also iron and steel making processes. Some of these are briefly mentioned here.

Raw Material Characterization and Beneficiation

The National Metallurgical Laboratory devoted much of its early efforts to the beneficiation of indigenous iron ores, coking coal and limestone. These studies were conducted on representative samples on a tonnage scale and encompassed virtually all the iron ore, limestone and coal deposits being exploited by the public sector and private steel plants for mineral beneficiation during it's formative years. The pioneering studies at NML have been greatly appreciated and implemented by the industry. Over 200 studies in the laboratory have indicated that washing of the ores is an absolute necessity to solve the problem of sticky and wet ores and to yield sized lumpy are for efficient blast furnace operation. Studies conducted at NML therefore addressed the twin issues beneficiation of fines and optimization of the conditions for sintering of the fines with and without fluxes.

Several parameters such as chemical analysis of raw materials, their size distribution, moisture content, fuel content and flux additions were varied and optimized. Extensive studies conducted in the laboratory have yielded valuable information on the sintering characteristics of Indian iron ores.

NML, in the last two decades, has been striving to characterize the raw materials for iron making processes. The studies include reducibility, thermal and reduction degradation and softening point of iron ore and the physical tests like shatter, tumbler and abrasion index of iron ore, coke, limestone and dolomite. The performance characteristics of reductant such as char reactivity and coal ash softening point have also been studied. The work undertaken at NML has provided the sponsors apriori knowledge of the physicochemical characteristics of the raw materials and helped them in selecting the suitable raw material combination for the production of desired quality of iron.

NML has carried out beneficiation studies on coking coal from several locations. Based on these studies, NML has provided know-how for the flotation circuit at Jamadoba and West Bokaro to TISCO, for Gidi to Central Coalfields Ltd., and for Dugda to Bharat Coking Coal Ltd.

NML has also studied on production of non-coking coal with less than 20% ash as a partial substitute for coking coal in the DR processes of iron making. The low ash (10%) non-coking coal

can also be used for direct injection in blast furnace to reduce the requirement of coking coal.

Studies conducted at NML have shown that low grade limestone can be beneficiated by flotation. In many of the limestones of interest, calcite is the principal carbonate mineral with small quantities of dolomite.

The limestone concentrates are in the form of fines and need to be briquetted or pelletised. NML developed the necessary know-how for this purpose and conducted several large scale trials in steel making furnaces.

Production of Sponge Iron

The Indian raw material has certain unfavourable features. NML has been engaged in the R&D efforts towards developing alternative routes utilizing the favourable characteristics of our raw materials which otherwise cannot be used in conventional iron making processes. The laboratory was the first to produce tonnage quantity DRI in India through a 4 ton/day capacity rotary kiln. NML later concentrated all its developmental efforts in the Vertical Retort Direct Reduction route. The process has been developed on 250 kg/day scale using solid reductants like non-coking coal, wood and other agricultural wastes. The process has a distinct advantage that it can be easily and successfully adopted by Mini Steel Plants to produce sponge iron sufficient for consumption in their own electric furnaces. In addition, it has a productivity 3-4 times of rotary kiln, degradation 1/3 to rotary kiln, investment cost -60% of rotary kiln and energy consumption 25% less than rotary kiln.

Foundry Grade Iron Technologies

A 10-12 ton/day low shaft furnace pilot plant was installed with the object of conducting extensive industrially oriented investigations and developmental work on the production of pig iron with substandard grade of raw materials particularly non-metallurgical fuels. During the 10 years i.e., 1959-69 of intermittent operation, several campaigns were conducted with raw materials collected from the different parts of India. Besides the variations in the physico-chemical characteristics of raw materials employed, alterations in operational conditions such as variation in hot blast temperature, wind rate, basicity of slag, dolomite addition to the burden, oxygen enrichment of the blast were imposed for comprehensive assessment.

The process parameters were evaluated and .optimized to produce the suitable grades of pig irons. It may also be mentioned that several hundred tonnes of foundry grade iron was produced using NML's low shaft furnace technology.

The pioneering work on the direct injection of highly volatile and inflammable liquid naphtha directly in the smelting zone of iron making furnace with simultaneous enrichment of the blast with oxygen was shown to be technically feasible and commercially acceptable. The extensive investigations have amply demonstrated the possibility of manufacturing of acceptable grade of pig iron ore fines and non metallurgical fuels in industrial scale. The process of iron smelting in small scale was found to be suitable to the developing countries lacking in raw materials which can be used in conventional blast furnace.

Pilot Studies on Steelmaking

Successful pilot plant trials were conducted at NML using a special type of converter designed and fabricated in the laboratory. The steel of composition: C=0.02%; P =0.035%; Si = 0.019%; Mn = 0.69%; S = 0.03%; was produced from the pig iron of composition: C = 3.2%; P = 0.39%; Si = 1.36%; Mn = 0.79%; S = 0.039%.

Investigations on top blowing with oxygen were also conducted for standardizing the Double Slagging Technique of refining ores with normal high silicon and medium phosphorous contents. The scope of this pilot study was carried out in early sixties to establish a 3 ton converter and study the applicability of Indian basic refractories including tarred dolomite to this process. A side blown converter (1500 kg) to undertake dephosphorization of the iron without the use of oxygen was installed. A pilot scale experimentation unit for the continuous casting technique both for nonferrous and ferrous alloys was installed. The research and development work on refractories vis-a-vis steel plant requirements including aerodynamic studies of combustion and flow of gases in a metallurgical furnace such as the open hearth steel furnace was also undertaken at NML.

NML's Role in R&D of Ferro-alloys Industry in India and Abroad

The National Metallurgical Laboratory has carried out extensive work on various aspects of alumino-thermic reactions and has to a considerable extent mastered the technique. Successful experiments have been carried out and the following alloys and metals have been produced: (i) ferro-titanium, (ii) carbon free ferrochrome, (iii) chromium metal, (iv) manganese metal, (v) chromium-manganese alloy, and (vi) ferro-vanadium from vanadium pentoxide.

NML has carried out the smelting trials of ferro-silicon production (70-74% silicon content) in its pilot plant scale 500 KVA submerged arc furnace for M/s. Bhutan Ferro Alloys Ltd., Bhutan. A number of compositions of charge mix were tried, decreasing the percentage of charcoal in the mixed reductants upto about 5% and process parameters were optimized.

Pilot Plants

In the initial years, the laboratory enjoyed virtual monopoly. It's research, development and pilot studies were suitably oriented to meet the urgent requirements necessitated by the rapid expansion of mineral and metallurgical industries during the successive Five Year Plans. It had many firsts to its credit. The laboratory established a number of pilot plants for arriving at the data needed to evaluate the techno-economics of many processes. The objective of many of these studies was the industrial implementation of research results through the establishment of the commercial scale operations. These pilot plants enabled the production, on a large scale, of metals, alloys and refractories. Some of the products resulting from these studies are: (i) Steel by oxygen injection in the L.D. Converter, (ii) Pig iron from low grade ores and non-coking coals in a low shaft furnace, a number of Ferro-alloys in a 500 kVA submerged arc furnace, (iii) manufacture of magnesium by silico-thermal reduction of

Dolomite on the scale of 250 tpa, (iv) electrolytic manganese dioxide for the battery industry and manganese metal, (v) dense carbon aggregates and Soderberg paste, (vi) beneficiated ores and minerals, (vii) nickel from lateritic ores of the country, (viii) copper, nickel and cobalt from the ocean nodules, (ix) pig iron through a gas fired coke-less cupola, (x) aluminised steel, and (xi) cryolite for the aluminium industry, and several others. Even today the laboratory can boast of the best available pilot plant infrastructure for beneficiating minerals, extracting ferrous and non-ferrous metals and studying refractory materials.

Based on the efforts of the laboratory, several commercial plants came into operation at various times. For example, close to 200 investigations conducted on the iron ores of the country led to the establishment of iron ore beneficiation plants in almost all of the integrated steel plants. Mention may be made of the iron ore washing and agglomeration plants at: (i) Naomundi for TISCO, (ii) Dalli Rajhara for Bhilai Steel Plant, (iii) Barsua for Rourkela Steel Plant, (iv) Goa for Iron & Steel Co., (v) Bolani for Durgapur Steel Plant, (vi) Kiriburu for Bokaro Steel Plant, (vii) Bailadila for Vizag Steel Plant, and (viii) Kanjimalai for Salem Steel Plant..

Similarly the extensive pilot plant studies on non-ferrous minerals and ores has helped the establishment of: (i) Malajhkhand and Rakha copper concentrators for Hindustan Copper Ltd., (ii) Bandalamattu lead-zinc ore concentrator for Hindustan -Zinc Ltd., (iii) Copper-lead-Zinc concentrator for the Sikkim Mining Corporation, (iv) Fluorospar concentrators for Gujarat Mineral development Corporation and for the Madhya Pradesh Minerals and Metals Corporation and (v) Graphite plant at Titlagarh.

Extensive studies carried out on coal washing greatly helped the establishment of the following coal washeries at: (i) Jamadoba and West Bokaro for Tata Steel, (ii) Giddi for Central Coal Limited, and (iii) Dugda for Bharat Coking Coal Ltd.

The technologies developed for the recovery of metals and Ferro-alloys from suitable raw materials have been transferred to several industries. Licences have been issued for a dozen industries for the production of Ferro-alloys such as Ferro-vanadium, Ferro-chrome, Ferro-tungsten, Ferro-titanium, Ferro-boron, Ferro-zirconium and Ferro-molybdenum. The know-how for the production of electrolytic manganese dioxide has been given to four different companies. A number of organisations are using the expertise provided by the laboratory for the production of metals from industrial wastes and scrap. The more recent plants established with the aid of the laboratory include:

- an oil/natural gas fired cupola at Agra,

- gas cleaning plants for environmental protection at IISCO's Central Growth Shop at Kulti,
- a ferro-vanadium unit at Jamshedpur, and
- a low-shaft furnace for the production of iron from low grade ores at Durg.

Besides, the laboratory has successfully completed several assignments from UNDP and for foreign countries. These concerned the beneficiation of:

- iron ores from Egypt, Syria and Nepal,
- manganese ores from Burma, Phillipines and Malaysia,
- chromite and limestone from Syria,
- zinc from Thailand, and
- phosphates from Uganda.

Extractive Metallurgy

Extraction of Non-ferrous metals has been an area of interest from the inception of the laboratory in the establishment of integrated steel plants. The extractive activity was therefore focused on the evaluation of indigenous raw materials for the production of ferro alloys using alumino-thermic processes and a 500 KVA pilot furnace. In due course, attention was turned to cryolite and its synthetic production, production of lead from galena concentrates and battery scrap, extraction of vanadium as its oxide from alumina sludge, extraction of tin from cassiterite and tin sludges etc. An important achievement of this era has been the establishment of a pilot plant for the production of magnesium metal through the Pidgeon process on the scale of 250 tpa. The pilot plant was subsequently reestablished in Andhra Pradesh by Southern Magnesium Chemicals Limited. The capacity has since been doubled and it is the only plant in the country producing magnesium metal. Currently, the design and fabrication of yet another process for the production of magnesium metal is underway. The Department of Mines and the Department of Science and Technology, Government of India generously support this activity. The plant is expected to go on steam towards the end of the current year.

A major activity undertaken by Non-Ferrous Extractive Metallurgy group over the last decade or so concerns the extraction of copper, nickel and cobalt from Indian ocean nodules. The process developed on a 100 Kg./day scale has the unique feature of adapting the reduction roast-ammonia leach technology (through redox control) followed by solvent extraction and electrowinning. Prior to these studies, the laboratory actively participated in the development of a process for the extraction of nickel with sister laboratories of CSIR. A technology demonstration plant has recently been set up at Bhubaneswar. In pursuit of some of these studies, well equipped large/pilot scale facilities have been established over the years for roasting (VRF/Rotary Kiln), smelting (SAF/Oil Fired/Electric Furnace), leaching (Atmospheric/ Pressure), solvent extraction (30 Stage-Mixer-Settler Battery), electrowinning/ refining, ammonia stripping etc.

R&D work on extraction of a host of non-ferrous metals such as Cu, Pb, Zn, Mg, Mn, Al, Sn, V, Mo,

W, Ni, Co, rare metals (Ga, Se, Te) and precious metals from primary and secondary resources/wastes and by-products, is in progress. Environmental studies and development of pollution free and energy efficient metal extraction and materials synthesis (high purity metal powders and oxides) technologies Including bio-processing are the major thrust of the current activities.

Alloy Development and Import Substitution

Several important projects undertaken by the laboratory pertained to the development of substitute alloys based on indigenous alloying elements to the exclusion of those that are scarce in India such as nickel, cobalt, molybdenum, tin etc. Some of these are - (i) the large scale production of nickel-free stainless steels containing chromium, nitrogen, manganese and copper, (ii) electric grade alloy aluminium conductors, (iii) aluminium coinage alloys, (iv) nickel-free heating elements based on iron, chromium and aluminium, (v) manganese-bearing brasses, (vi) tinless bronzes, (vii) bimetallic strips, (viii) high strength low alloy steels with manganese, copper, silicon and chromium, (ix) dental amalgams, and (x) heat resistant cast irons. A number of facilities and equipment needed to be created or fabricated for the purpose of evaluating the performance of such indigenously developed alloys and refractory materials. The establishment of the following facilities in the laboratory for such a purpose is noteworthy-

- a creep testing facility capable of handling close to 250 samples at a time upto temperatures of 1000°C,
- apparatus for the measurement of elastic constants with ultrasonics,
- vacuum fusion apparatus for the determination of gases in metals,
- facility for the determination of the thermal conductivity of materials,
- vertical and horizantal furnaces for the treatment of ferruginous manganese ores,
- reciprocating motion sliding friction testing machine for the determination of coefficient of friction,
- equipment for the comparative evaluation of heating elements,
- set up for the accelerated fatigue test,
- And- side blown basic converter of 500 kg and 1500 kg capacity.

Except for the creep facility all others were designed and constructed in the laboratory. Many of these facilities and those created with loans from the World Bank are being used for the remaining life assessment of plant machinery and components as well as combat aircraft.

n 1993, a major effort was initiated to exploit the expertise gained over many decades at evaluating the remaining life of engineering lcomponents. Many equipments for the non-destructive examination and mechanical testing of materials were added to the already existing creep facility with the aid of a substantial loan from the World bank. Major industrial establishments, Public Sector undertakings and Government agencies viz., Tata Steel, Steel Authority of India Ltd., Bharat Petroleum, Indian Oil and the Department of Atomic Energy

supported a number of fundamental studies and investigations specific to their own needs through generous grants. Software has been developed for the remaining life estimation under fatigue and creep conditions and given to the sponsors for field evaluation. As a result of the additional strengths generated in the process, the laboratory has been registered, along with Metallurgical Consultants (MECON), with the Power Finance Corporation for the remaining life of power plant components. The Centre for Military Airworthiness Certification (CEMILAC) has recognized the laboratory for the failure analysis of military aircraft.

Refractory Material Development

Refractory materials form an integral part of many metallurgical furnaces. Recognising this aspect, the laboratory was involved in studies on the development of refractory material technologies right from its inception. Efforts were directed at helping both the small and heavy industries in this vital area. Extensive studies were conducted on indigenous raw materials to assess their suitability for the manufacture of different kinds of refractories. Basic studies on the high temperature kinetics of important reactions, phase transformations, resistance to corrosion etc., were also undertaken. The laboratory has actively participated in the formulation of national standards for refractories.

Technologies have been developed for the production of graphite crucibles with various bonding agents, for the manufacture of tabular alumina, foam insulation refractories, ramming masses and castable refractory materials.

Synthesis techniques for high purity nano-crystalline alumina and borides, nitrides and carbides, of commercial importance, by recent methods are some examples of work in this vital area. Current activities also include studies on synthesis and characterisation of functionally graded materials. In recent times, the group has been concentrating on the utilisation of industrial waste such as fly ash, iron ore slimes, red mud etc., for the manufacture of value added products such as tiles, wear resistance liners and sound insulators.

Corrosion Studies

NML has developed and successfully marketed a number of technologies and corrosion protection products. Some of these are inhibitors for pickling of steels and non-ferrous materials in acid baths, aluminium-based galvanic and insoluble anodes for cathodic protection, paints and coatings for corrosion prevention etc. Products such as ethyl silicate-based zinc rich paint, rust converter, passivator for galvanised steel have found industrial application. Techniques for calorising of steel, anodising of aluminium, electroless plating of nickel and phosphating have been developed and transferred to small and medium scale industries. The process of corrosion has also been exploited beneficially to produce stainless steel powder while electrolytic processes for powders of iron, silver, nickel and copper have also been developed.

The laboratory has been instrumental in developing the first corrosion map of India and establishing a Marine Corrosion Research Station at Digha in West Bengal. This region has the

highest rate of corrosion on the eastern coast of India and this Station has helped in assessing the suitability of many newly developed metallic materials for marine applications.

Modelling

Several Research Divisions of the Laboratory have been active over the last two decades in both Mathematical and Physical Modelling of MetallurgicaL Processes. The studies, which have covered extremely diverse areas ranging from models for flow phenomena in continuous casting through evaluation of microstructure during welding. There have been tremendous advances in our understanding of the processes that take place in the blast furnace, the workhorse of the iron and steel industry. These have helped, many an advanced country, achieve great improvements in the productivity of the furnace. With a view to bring such knowledge to bear on the operation of our own furnaces, the laboratory has joined hands with Tata Steel and Steel Authority of India in developing mathematical models for the individual processes that take place in the furnace with the aim of improving the productivity. This effort is funded by the Steel Development Fund of the Department of Steel, Government of India.

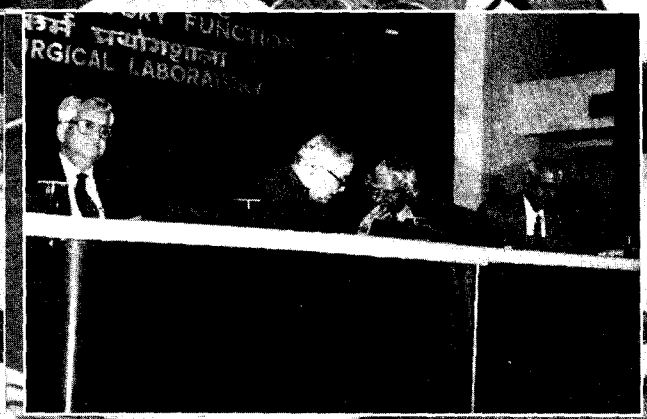
LOOKING AHEAD

The NML is an, ISO 9001 2000 certified organization. In the course of it's efforts in this direction a great need was felt for the calibration of all the measuring and testing equipment at a level which is of international standard. To meet this need and also to be of service to the other Industries in and around Jamshedpur, the laboratory has recently established a Calibration Centre in association with the National Physical Laboratory, New Delhi the latter is the custodian of national standards and the joint venture is a step in the direction of giving a visible shape to the TEAM CSIR spirit. This service is in addition to the service, which the laboratory has been rendering to the metallurgical industry by way of preparation and supply of Standard Reference Material for chemical analysis. This activity which was originally started in association with the National Bureau of Standards, Washington, USA with financial support under the PL480 programme has since grown enormously. The standard reference materials are also exported to Germany, Australia and some Arabian countries.

Besides undertaking research sponsored by the industry and the government, the laboratory also conducts in-house research in relevant and emerging areas to keep itself abreast of the developments in the areas of metallurgy and materials science. It has been consistently producing a large number of technical publications in reputed journals and filing patents embodying new results with the potential of industrial exploitation. It has received recognition of these efforts through many awards and honors.

In keeping with the expectations of it's founding fathers, NML has constantly striven to understand and respect our past and build on it for the future.

FIG. 105 – SHRI P. VENKATARAMAN, MINISTER FOR INDUSTRIES, GOVT. OF MADRAS, CHAIRING THE ANIL BOARDING SESSION, MADRAS. DR. JEBAKUMAR GRANDI, CHEMICAL EDUCATION CONSULT., NATIONAL METALLURGICAL LABORATORY, IS ON THE RIGHT SIDE OF THE MINISTER.



Prof. R. Chidambaram, Principal Scientific Adviser to the Govt. of India, interacting with scientists. On his left Prof. S. P. Mehrotra, Director NML

In the perspective of Development of Science Teaching in Garo Hills

Dr. Kaushik Kr. Bhattacharjee,
Retd. Principal,
C.T.E., Tura.

This article is an attempt to make an assessment of development of Science Education in Garo Hills for last four decades. Incidentally this period coincides with the entire period of my service. I joined in October, 1974 as a Teacher in the Department of Chemistry, Tura Government College, Tura followed by appointment as Principal in the College of Teacher of Education, Tura and finally retiring from the service in August, 2010.

The scenario in higher education in Garo Hills in 70's decade was that there was only one college "Tura Government College" which catered to the needs of higher education in entire Garo Hills. The college was taken over by the then Government of Assam in 1957. The students of this part of the state had only one option, either to join this college or to go outside Garo Hills. Again at that time the college was having only degree pass and Honours courses in Arts stream only.

The science and commerce stream was only up to the level of pre-degree level called Pre-university. After the creation of the state of Meghalaya, the Government of Meghalaya felt the need of opening the degree course in Science. So when I joined the college our main task was quite daunting, i.e. to pioneer higher education in science along with a challenging task to establish science laboratory for the degree classes. This was a humble beginning with very few students. They co-operated in every possible way. All the teachers devoted their full energy and commitment. In fact students of this part of the state are most decent and co-operative. The atmosphere in the college was very congenial. Then after a period of about 10 years the need for opening of Honours courses in science was felt and North Eastern Hill University gave permission to open the Honours courses in Science subjects.

During 1980s another institute at the college level came up in Tura, i.e. Don Bosco College. This institute is providing quality education to the students and science stream in the college has been performing creditably both in higher secondary and degree level. However, it is apparent that most of the institutes are urban based and students from the rural areas are to throng to this urbanized localities which puts immense pressure on their financial and social capabilities.

At this period of time (early 1990s), the Pre-university courses was delinked from NEHU and was taken up by Meghalaya Board of School Education (MBOSE), Tura. Since then the Higher Secondary courses in Arts, Science and commerce courses are conducted by MBOSE. After few years it was realized that the students of Meghalaya are not at par with the students at the National level. So the need for changing the syllabus was felt by all concerned. So after a series of attempts of seminar and discussion conducted by DERT and many science teachers of the state, the syllabus of CBSE was adopted by the Board for the Science course. This was a major change and it benefited all. But it is worth mentioning that although the books of the CBSE written by NCERT were initially prescribed but later the books were changed and books written by other authors were introduced. These books definitely are not at par with the books recommended by NCERT both with respect to quality and price. This particular act and few other such smaller but significant actions by various authorities have given a set-back to the efforts of teaching fraternity in their effort to build a solid scientific outlook amongst the students. Such cases may be identified as the ones which contribute to fear psychosis prevalent amongst the younger generation about studies in science and mathematics though they have the necessary enthusiasm and urge to take science as their career option.

Again as per norms of UGC the degree colleges need to delink higher secondary courses from the degree colleges. Few colleges have done this and others are planning to go in this direction and it will take some time to do it. This will benefit students in the degree colleges, which means college teachers will be able to devote more for the degree students and will be able to produce quality graduates and many students of the state is expected to be placed in All India Services and other jobs in the National level. Again regarding delinking of Higher Secondary students from degree colleges it might be necessary to create adequate numbers of public-funded "Higher Secondary institutions" or "Junior colleges", particularly in Garo Hills where such institutions are few and far between. In these institutions usually only one subject teacher is appointed. Moreover, in view of the load and content of the syllabus for the benefit of students a minimum of two subject teachers should be appointed and I hope Government will think in this regard. At the same time vocational courses both at the Secondary and Higher secondary level should be available in the state which will be job oriented.

Now in order to spread education amongst the masses and bring a good number of quality students in the science stream the science teachers has to put an additional effort. Out of such efforts one of this is done by a NGO which is "Meghalaya Science Society". Incidentally this organization was established in Shillong in 1973. In the year 1978 a branch of this organization was established in Tura and since then this organization is functioning successfully in creating a science temperament amongst the masses particularly in the students of rural areas in West Garo Hills. The Meghalaya Science Society, Tura, reaches to the most interior of the students in the rural area (in each block) and conducts various programmes which create an

interest in the studies of science. In this endeavor the Science and Technology Cell of Planning department Government of Meghalaya gives its full support. Mention should be made that the parent body of this society being defunct in Shillong. The Tura unit has now registered itself as parent body. Now the Science teachers of Shillong can make an attempt to reestablish this organization and contributes to the society.

Regarding the method of teaching in schools I had the opportunity to gather some experience while serving as a Principal of B. Ed college. These colleges are now called "College of Teacher Education". In our state there are three such institutions with intake capacity of 100 students. Now every year out of a total 300 no of students are admitted for training. Here approximately about 50 students admitted are from outside the state, so only about 250 trained teachers are available to join the schools of Meghalaya (if all of them join the service). Now care should be taken the mostly students o Meghalaya are admitted in these institutions. Further the intake capacity of these institutions can be increased by recruiting some more Lecturers in the B. Ed Colleges with some additional creation of infrastructure.

Again it is found that when the teachers from these institutions are trained so well if they follow these methods of teaching then the students shall be highly benefited. But it is unfortunate to mention that these trained teachers, with some exceptions, hardly adopt or follow these methods. Therefore the authority concerned should regularly check if the methods of teaching are followed meticulously in all the schools of Meghalaya.

At this stage, I would like to make an appeal to the Government to consider finding ways and means to make the teaching profession in the State right from primary to collegiate level little more attractive and rewarding. Providing job security, social security benefits and minimum service benefits like medical insurance/allowance and housing schemes are the essential pre-requisites for attracting best talents in teaching profession which will contribute to the development proper academic environment not only in teaching science but all other streams. Further, academic bodies must be administered by academicians with administrative acumen and bureaucratic interferences hamper and pollute the academic environment.

The forgoing paragraph probably requires some elaboration to justify the claims. It is accepted knowledge that only a conducive situation for dedication, commitment and understanding of the personal along with the environment for research in science give birth to the scientists for the nation which ensures progress and development. Basically we need a brand of people who cultivates and imparts analytical mindset, looks at all development around him/her with a rational approach and condemns and fights against all superstitions, obscurantism and regressive traditional beliefs. These conditions will contribute to the development of a progressive scientific society which will certainly foster inquisitive mind among generations of young mind and ensure progress of science in our country, particularly in our state.

In overall Indian context, Roddam Narasimha of the Jawaharalal Nehru Centre for Advanced Scientific Research in Bangalore commented that, "We are neither able to provide equity of education nor excellence in education. Most distressing was that the quality of students appearing for scientific programmes was well below the standards. This was especially true with regard to pure sciences where the quality of students was distressingly low". According to him India has a major educational problem as it is neither able to provide education for all nor is it even able to provide quality education for the few. The stagnation of the standard of education in pure sciences was partly because of the growth in information technology and partly because the stream was not financially lucrative. "Students with a basic engineering degree or somebody working at a call centre can earn much more than a Ph.D. student," he said. The root cause for all this to happen is to do with our education and social perception of it.

It is often very loosely commented by the people in power that the quality of education has come down. This is neither agreeable nor true but what is certainly agreeable is that the direction of education has changed in a way that give more emphasis on information than knowledge though one hears a very impressive slogan of creating "a knowledge based society". Earlier, education was a hallowed profession for gaining knowledge. Today, it is an investment for future prosperous living. The craze of the students for joining professional courses should be seen in this light. It does not mean that most of them or their parents have a great love for these courses but they perceive them to be a passport for lucrative jobs. Money seems to be calling the shots. The situation would not remain like this forever. No icon in the past has remained for a long time. If you care to see the writing on the wall, the icon of 'money' is slowly giving way for something else. These icons like everything else in life are cyclical. There are enough indications that our country would awaken once again to those eternal values for which this land has stood for many centuries. Does it mean that we have to wait till this natural process continues and then people would realise the worth of basic sciences and turn towards it? No. Efforts should be multiplied to arrest this lop sided growth and to educate our children about the charm of sciences. We should catch the imagination of a child today to produce a Nobel laureate of tomorrow. We should make teaching of science in the schools truly exciting and enjoyable. That is a worthwhile investment for the secure future of this glorious country.

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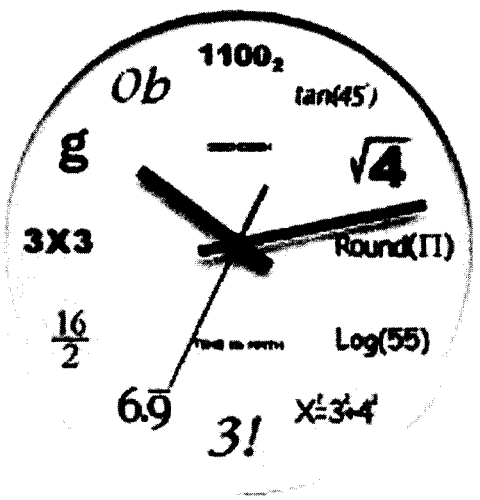
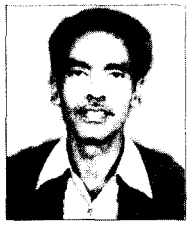


Big Bang Experiment and Indian participation

Prof. (Retd.) Ranjit Kumar Datta
Formerly Vice Principal and Head,
Department of Physics, Shillong College, Shillong



After a search for about half a century, scientists at the world's biggest atom smasher inside European Centre for Nuclear Research (CERN) announced on 4th July 2012 that they had discovered a new subatomic particle that was very similar to Higgs boson generally known as God particle and are supposed to be responsible for imparting mass to matter.

The discovery of Higgs boson is important because it would validate the Standard Model a theory which identifies the building blocks of matter. According to the standard model, the universe is made of twelve fundamental particles and four fundamental forces. One more particle was predicted by three scientists Higgs, Brout & Englert in 1964. The particle was called Higgs boson.

To discover Higgs boson scientist's world over wanted to create Big Bang condition. A large Hadron collider (LHC) was constructed at CERN. The LHC is a twenty seven kilometre looped pipe set up in a tunnel 175 meter underground on Switzerland-France border. It has four huge laboratories around the ring shaped tunnel near Geneva. The circumference of the pipe is 26,659 meter & has 9,300 magnets inside. To compute LHC's data tens of thousands of computers around the worlds are used in computing network called the Grid. In the LHC beams of protons are accelerated in opposite directions to more than 99.9999 % of the speed of light. Super chilled magnets bend the beams & streams of protons collide within the four large chambers. The smash of protons generate temperature 1, 00,000 times hotter than the sun, replicating conditions just after Big Bang. Detectors give 3D images of subatomic particles from proton's smashing. The LHC generated 600 million collisions per sec. The project is likely to throw light on source of dark matter, dark energy, matter & anti-matter. During proton's smash quarks & gluons inside the proton's collide & explode with energy sufficient to create Higgs boson. The Higgs boson has 100 to 200 times the mass of a proton & last for about 10-24 second & decay into other particles.

Tens of thousands of physicists are engaged in the search. Two CERN laboratories working independently found the new particle in the mass region around 125-126 GeV. Scientists at

CERN announced that a new particle had been found. It is the heaviest Boson. But they do not confirm the discovery of Higgs boson because all the properties are yet to be confirmed though the mass range fits the Higgs boson range of mass. The discovery confirms the Standard Model theory. But there are other aspects of particle physics & of the cosmos that are yet to be explained. The dark matter which makes up 25 % of the matter in the universe is yet to be discovered. Dark energy which makes up 70% of matter in the universe is not located.

The Indian participation in the CERN activities is significant. Scientists from Delhi & Kolkata have been engaged for the last 15 years or more. Scientists from Kolkata particularly from Saha Institute of Nuclear Physics (SINP) & Variable Energy Cyclotron Centre (VECC) made significant contribution at the CERN activities. The SINP scientists are members of the Compact Muon Solenoid (CMS) in the CERN investigation & they aided the search with data analysis & by developing hardware for the experiment. The discovery is likely to pave the way for new insights into particle physics. It is believed that SINP & rather India will play a greater role in future. India may be granted the status of an associate member. The CMS team from SINP has worked on several aspects of the experiment particularly in the development of silicon track detectors installed in LHC & data analysis through grid computing.

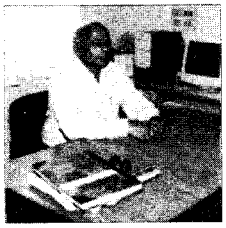
Rolf-Dieter Heuer, the Director General of CERN came to Kolkata recently to participate in an inter-disciplinary scientific meet titled Frontiers of Science. He said he was privileged to be in the country that was like a historical father of the high profile Higgs boson project in search of the building blocks of the cosmos. Indian physicist Satendranath Bose's name is intrinsically linked to particle physics after English physicist P.A.M Dirac coined the term "boson" to commemorate the contribution of S.N Bose in describing the behaviour of certain particles. Heuer lamented that S.N Bose did not win Nobel Prize for his work in Bose Einstein statistics & Bose Einstein condense. But several Nobel Prizes have been awarded for research related to boson & Bose Einstein statistics.

CERN diversity programme head & member of HR Management board Sudeshna Dutta Cockerill who hails from Kolkata but a Swiss national now, has been working at CERN for over 30 years. She said that there are at least 250 Indian national working in CERN at present and with another 100 plus scientists of Indian origin but with different nationalities; the Indian community is very strong & can become more dominant if India becomes an associate member.

The Large Hadron Collider (LHC) is said to be shut down for two years from February, 2013 for upgrade & maintenance. Saha Institute of Nuclear Physics (SINP) & the Variable Energy Cyclotron Centre (VECC) are readying for greater participation over newer experiments at CERN. The SINP will be more actively associated with CERN for five more years. VECC which has been involved with CERN since 1989, plans to participate in the maintenance & refurbishing of Photon Multiplicity Detector (PMD). However, VECC's immediate programme is to analyse the huge data collected from the experiments.

DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN INDIA

Dr. S. K. GUPTA
Former, Vice Principal (Professional courses)
&
Former Head, Department of Chemistry
Shillong College, Shillong-793003, Meghalaya, India.



INTRODUCTION

The word "SCIENCE" has a Latin root meaning knowledge; it is concerned with human understanding of the real world around- the inherent properties of space, matter, energy and their interaction. It is the concomitant of the enquiring mind, wanting to unravel the mysteries of nature, unbiased, fearless and free.

"TECHNOLOGY" on the other hand, has Greek root which means application of science. Technology is the systematic knowledge and action, usually of industrial processes but applicable to any recurrent activity. The term covers the practice, description and terminology of any or all of the applied sciences which has practical value and/or industrial use. It is closely related to engineering. If engineering is the application of the objective knowledge to the creation of plans, designs, and means for achieving desired objectives, technology deals with the tools and techniques for carrying out the plans.

Science and Technology have always been part of the development process and profoundly influenced the course of human civilization. One of the activities through which culture broadly expresses itself is intellectual, and scientific advancement is an aspect of the intellectual activity. In the modern world, Science and Technology have become indispensable. Science generates information, change in attitudes and new values and Technology is a major instrument of social and economic change.

AWAKENING OF MODERN SCIENCE IN INDIA

The scientific revolution of the 20th century has led to many technologies, which promise to herald wholly new eras in many fields. As we stand today at the beginning of a new century, we have to ensure fullest use of these developments for the well-being of our people.

Science and Technology have been an integral part of Indian civilization and culture over the past several millennia. During the century prior to independence, there was an awakening of modern science in India through the efforts of a number of outstanding scientists. They were responsible for great scientific advances of the highest international caliber.

Apart from the vast changes it has brought about, the development of a scientific temper in the people is considered important. In the planned economy of a country, Science must necessarily play an especially important role. Improvements in techniques evolved as a result of scientific

research brings about great increase in production in different sectors of the economy. National resources are augmented by the substitution of cheap and abundant materials for those in scarce supplies and by finding use for materials, which have remained unutilized. Prior to Independence, a very little attention was given to the problems of scientific and industrial research in India. The British brought to India contemporary Science and Technology --- what is often termed as "Modern Science and Technology". However the educational and research developments in this period were directed to meet the British Government's needs, and not primarily meant for India's socio-economic betterment. But unwittingly perhaps, these activities promoted indigenous efforts to develop scientific thought.

FOUNDATION OF SCIENTIFIC SOCIETIES

The foundation of the Asiatic Society in the year 1784, by Sir William Jones starts the beginning of the public interest in scientific research. The Society published papers in Chemistry, Physics, Geology and Medical sciences and these played an important role in the advancement of Science in India.

The Indian Association for the cultivation of Science (IACS) founded in the year 1876, by Dr Mahendra Lal Sircar, provided laboratory facilities and became a premier scientific research center in the country. The Bombay Natural History Society which was founded in the year 1883, and Indian Mathematical Society which was established in the year 1907, mainly due to the efforts of Shri V. Rangaswami Iyer under the name of Analytical Club. Calcutta Mathematical Society was founded in the year 1908, with Sir Ashutosh Mukhopadhya as the first President, with the objects of fostering and encouraging the study of Mathematics in all its branches, promoting the spirit of original research and publishing a periodical. Indian Science Congress Association was founded in the year 1914 due to the joint of Prof P. S. Macmohan of Lucknow and Prof Simon of Madras. The establishment of these scientific societies played a major role in creating a scientific awareness in bringing scientists together and enabling them to make the Government to give support to scientific research.

The Trigonometrical Survey of the Peninsula of India was established in the year 1800 and was expanded as Great Trigonometrical Survey of India in the year 1818.The Topographical and Revenue Surveys grouped together under the Surveyor General of India in the year 1817 and a School of Surveying was established in Madras, later on, were consolidated with Trigonometrical Survey in the year 1818 as the Survey of India.

The Botanical Gardens was established in the year 1788. Dr William Roxbery was the first person to start research on Indian Plants. The Botanical Survey of India (BSI) was established in the year 1890. In the year 1916, the Zoological and Anthropological Sections of Indian Museum of Calcutta, which was founded in the year 1866, were converted into Zoological Survey of India (ZSI).

In the year 1892, the first Bacteriological Laboratory was established at Agra to develop vaccines relating to diseases like plague, cholera, malaria, beriberi, kala-azar etc. The Pasteur Institute was founded at Kasauli in the year 1900. In the year 1907, another Pasteur Institute was set up at Coonoor. In the year 1910, Sir Leonard Rogers proposed the establishment of the School of Tropical Medicine in Calcutta. Thus a number of laboratories with facilities of medical research were established. Sir Harcourt Butler of the department of Education, Health and lands, of the.

Viceroy's Executive Council and Sir Pardy Lukis, the Director General, Indian Medical Service, worked towards the foundation of an Indian Research Fund Association in the year 1911, with objectives of research, propagation of knowledge and experimental measures generally in connection with causation, mode of spread and prevention of communicable diseases. In the field of Cancer disease, the Tata Memorial Hospital, Bombay, was established in the year 1941 by the Dorabje Tata Trust.

In order to deal with policy, administration, coordination of Agricultural Research and Education, in the year 1929, the Imperial Council of Agricultural Research was established. The Council was also acting as a catalyst to link between Agricultural Institutions in India and other countries

FOUNDATION OF SCIENTIFIC INSTITUTES BY SCIENTISTS AND PUBLIC PERSONALITIES

A number of institutes were also founded/established by Scientists and Public Personalities, some of them are Indian Institute of Science , Bangalore by Shri Jamshedji Nusserwanji Tata in the year 1909, The Indian Statistical Institute, Calcutta, by Dr Prasanta Chandra Mahalnobis in the year 1931,The Bose Institute, Calcutta by Dr Jagadish Chandra Bose in the year 1917, The Indian Academy of Sciences, Bangalore by the Noble Laureate and Bharat Ratna Awardee Sir Chandrasekhara Venkata Raman in the year 1934,Sheila Dhar Institute of Soil Science, Allahabad by Prof Nil Ratan Dhar in the year 1936, Raman Research Institute, Bangalore, by Sir Chandrasekhara Venkata Raman in the year 1943, Tata Institute of Fundamental Research, Bombay in the year 1945, Shri Ram Institute for Industrial Research,Delhi by Sir Lala Shri Ram in the year 1947, The Institute Of Nuclear Physics, Calcutta, by Dr Meghnad Saha in the year 1955. Indian Institute of Science, Bangalore played a very important role as a center of research at a time when India possessed a very few research facilities. Their development was accelerated only after Independence, and now they are the centers of higher studies and research.

A decade before Independence, India witnessed the intervention of the Second World War with the scientific activity being directed to meet specific needs of a temporal nature.

In the year 1940, the Government of India constituted the Board of Scientific and Industrial Research and subsequently the Council of Scientific and Industrial Research (CSIR) was founded in the year 1942, for the purpose of fostering industrial development in the country. After the Independence a number of research institutes like National Physical Laboratory, National Chemical Laboratory and other laboratories for Food Technology, Building, Road, Leather, Electro-chemicals were established, incidentally on the lines of the Institutes established in United Kingdom under the Department of Scientific and Industrial Research.

NEW DIMENSIONS IN SCIENCE AND TECHNOLOGY AFTER INDEPENDENCE

Science and Technology in India assumed new dimensions soon after its Independence motivated by an active encouragement by the Government due to the vision and foresight of India's first Prime Minister Pandit Jawahar Lal Nehru who was fully cognizant of the indispensability of Science and Technology in the economic and social development of the country. Considering planning to be Science in action and the Scientific method the very essence of planning, a scientific Policy Resolution was adopted in Parliament in the year

1958. The aim of the policy is to foster, promote and sustain the cultivation of sciences and scientific research in the country and to encourage individual initiative for dissemination of scientific knowledge and to ensure that the creative talent of men and women is encouraged to find full scope in scientific activity; above all to secure that the benefits that can accrue from the acquisition and application of scientific knowledge should be utilized for the people of the country.

As the science progressed, it was felt the need of newer indigenous technologies to be developed. The Technology Policy Statement, of the year 1983, grew out of the felt needed for guidelines to cover a wide ranging and complex set of its related areas.

In order to implement the Technology Policy , the Government set up an Implementation Committee and later as a new autonomous body "Technology Information Forecasting and Assessment Council" (TIFAC) was established in the year 1987.It has undertaken an important project for integrated, computerized, interactive and decentralized nationally accessible technology system. Technology Forecasting & Assessment studies have undertaken for Petrochemicals, Housing & Building technology and skills, Human Settlement Planning, Technology, Modernization of Steel Plants, Sugar, Fertilizers, Energy, Electronic Materials etc. These policies have emphasized self-reliance, as also sustainable and equitable development. Plans and policies have to be implemented, research and development have to be funded, manpower has to be created and effectively utilized, if Science and Technology are to play a meaningful role in the development of the country. Scientific activities in our country are mainly conducted by the government departments, higher educational centers, industry, both public and private sectors and non-profit associations. In the year 1994, the Government set up a 'Cabinet Committee' on 'Science and Technology' which would decide on policies and programs, key areas in industry, agriculture and other economic sectors. There are six major scientific department-- Department of Science and Technology, Department of Scientific and Industrial Research, Department of Bio-Technology, Department of Ocean Development, Department of Space and the Department of Atomic Energy, besides a host of other organizations like Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR) etc.

INTERAND MULTIDISCIPLINARY ROLE OF SCIENCE AND TECHNOLOGY

Science is becoming increasingly inter and multi-disciplinary, and calls for multi-institutional and, in several cases, multi-country participation major experimental facilities, even in several areas of basic research, require very large amount of materials, human and intellectual resources. Science and Technology have become so closely intertwined, and so reinforce each other that, to be effective and any policy needs to view them together. The continuing revolutions in the field of Information and Communication Technology have had profound impact on the manner and speed with which scientific information becomes available, and scientific interactions take place.

Science and Technology have had unprecedented impact on economic growth and social development. Knowledge has become a source of economic might and power. This has led to increase restrictions on sharing of knowledge, to new norms of intellectual property rights, and to global trade and technology control regions. The

ongoing globalization and the intensely competitive environment have a significant impact on the production and service sectors. Successes in Agriculture, Health-care, Chemical and Pharmaceuticals, Nuclear Energy, Astronomy and Astrophysics, Space Technology, Defense Research, Bio-Technology and Oceanography are widely acknowledged.

Because of all this, our Science and Technology system has to be infused with new vitality if it is to play a decisive and beneficial role in advancing the well-being of all sections of our society. The nation continues to be firm in its resolution to support Science and Technology in all its facets. It recognizes its central role in raising the quality of lifestyle of the people of the country, in making India globally competitive, in utilizing natural resources in a suitable manner, in protecting the environment and ensuring national security.

NUCLEAR ENERGY PROGRAMME

Nuclear energy development is being geared up by the Chief Architect of our Atomic Energy Pillar Dr Homi Jehangir Bhabha, former Chairman, Atomic Energy Commission of India who has contributed significantly to overall energy availability in the country. The prime objective of India's nuclear energy for peaceful purposes such as power generation, applications in agriculture, medicine, industry, research and other areas. India is today recognized as one of the countries among the advanced countries in nuclear technology including production of source materials. The country is self-reliant and has mastered the expertise covering the complete nuclear cycle -- from exploration and mining to power generation and waste management. Accelerators and power reactors are now designed and built indigenously.

DEVELOPEMENT IN SPACE TECHNOLOGY

In the field of Space Technology, India is among the five top nations of the world. The Indian Space Research Organization (ISRO), under the Department of Space, is responsible for research, development and operation in space systems in the area of Satellite Communications, Remote Sensing for resource survey, Environmental monitoring and Meteorological services etc. Department of Space is also the nodal agency for the Physical Research Laboratory which conducts research in the areas of Space Science, and the National Remote Sensing Agency which develops modern remote sensing techniques for natural resource surveys and provides operational services to user agencies. India is the only third world country to develop its own remote sensing satellite. India joined a select group of six nations on 15th October 1994 when the Polar Satellite Launch Vehicle (PSLV) successfully accomplished its mission of placing the 800 kg remote sensing satellite in the intended orbit.

The INSAT series of satellite launched earlier are performing well and provide vital services for Telecommunications, Television, Meteorology, and Disaster warning and distress detection. The latest INSAT series has included new features like the Ku-band transponders and mobile satellite services.

The most significant milestone of the Indian Space Programme was the successful launch of PSLV-C6 on 5th May 2006.The ninth flight of Pola Satellite Launch Vehicle from Satish Dhawan Space Centre, Sriharikota, successfully placed two satellites- 1560 kg CAROSTAR-1 and 42Kg HAMSAT into a predetermined polar Sun Synchronous Orbit (SSO). The successful launch of INSAT- 4A, the

heaviest and most powerful satellite built by Indian, on 22nd December 2005 which is capable of providing Direct-To- Home (DTH) Television Broadcasting Services. The Indian Space programme entered a new era when ISRO's Polar Satellite Launch Vehicle (PSLV)-C7, successfully launched on 10th January 2007, four satellites into higher polar orbit from Satish Dhawan Space Centre. The four satellites put into orbit were India's CARTUSAT-2 and Space capsule Recovery.

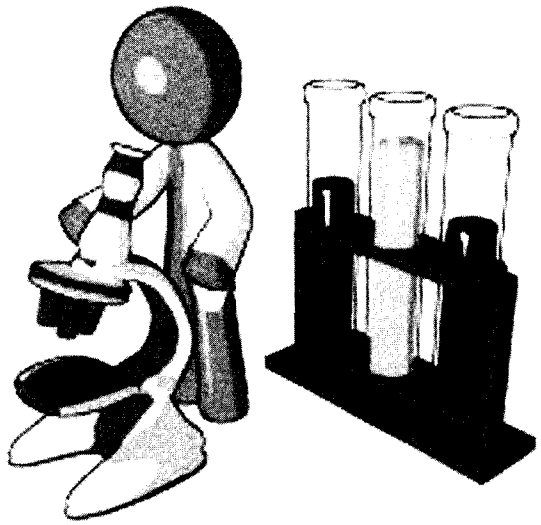
Experiment, Indonesia's LAPAN-TUBSAT and Argentina's PEHUENSAT-1.

India's progress in Space Technology is due to primarily efforts of the Father of the Indian Space Programme Dr Vikram Ambalal Sarabhai, which has now attracted worldwide attention and demand, with leasing agreements for marketing of IRS data and supply of space hardware and services. India also believes in cooperation in space with other agencies of the world. India is on the threshold of achieving self-reliance in the launch capability.

CONCLUSION

India has been the forerunner among the developing countries in promoting multidisciplinary activities in the field of Bio-technology, recognizing the practically unlimited possibility of their applications in increasing Agricultural and Industrial production and in improving human and animal life. The nucleus of research in the field of Bio-technology was advanced after the formation of the National Biotechnology Board in the year 1982.Some of the new initiatives taken which include developing techniques for Gene mapping, conservation of Biodiversity and Bio-indicator's Research and Plantation of Crops. The areas, which have been receiving attention, are cattle herd improvement through embryo transfer technology, in vitro propagation of disease resistant plant varieties for obtaining higher yields and development of vaccines for various diseases.

Thus, we see that India has made unprecedented development in Science and Technology during the post-independence period and this just seems to be the beginning of a road to endless possibilities. At present, India has one of the largest Science and Technology manpower in the world. All we need is to plan and organize in a way so as to be able to harness our intelligentsia in the right direction and provide it with the right opportunities.



TEACHING OF SCIENCE IN SCHOOLS & COLLEGES

Durbadal Mukherjee
Former Vice Principal & Professor
Head, Department of Physics,
Shillong College

I am extremely happy to be a part of the golden Jubilee Celebration of "Teaching Science in Shillong College" and I congratulate the authority and the management of the College for organising such a great event in the history of the College. I also thank the Organising Committee of the Golden Jubilee Celebrations for giving me an opportunity to venture this article for the Souvenir to be published on this occasion.

Please allow me a short nostalgic trip to have a peep into the beginning of my teaching career in this College. I joined Shillong College as a Lecturer in Physics on 1st august, 1969, i.e. just six years after the start of the science stream in 1963. (Late) Shri Sudhindra Chandra Dutta, an educationist and administrator par excellence and an eminent scholar in Mathematics was the founder Principal of the College and it was under his stewardship as also through the untiring efforts of his colleagues, that Science Stream was established in Shillong College. The Departments of Chemistry, Zoology, Botany and Physics were started in 1963. Department of Mathematics was already there under the Arts Stream with Prof. Bankim Chandra Goswami as the Head of the Department. When I joined the College, (Late) Prof. Purushottam Deb, (Late) Prof. Kamalaksha Dutta and Prof. Umesh Chandra Kakati were the Heads of the department of Chemistry, Zoology and Botany respectively. The faculty of Physics Department comprised of Prof. Ranjit Kumar Dutta (HOD), Prof. Udayan Ghosh, myself and Shri Rajat Kanti Das (Demonstrator). In those days, we used to teach students up to U. G. (pass level). At a later stage, honours in different science subjects were introduced in a phased manner to cater to the needs of the aspiring students. Students represented all the strata of the society and usually there was a personal cordial relationship between the teachers and the students. In general, the students were serious, sincere and well behaved. We always entertained students visiting us during the short breaks or off periods and encouraged them to share their thoughts with us with an open mind and tried to help solves their problems. These personal interactions, I believe, facilitated creating a congenial ambience for effective teaching-learning process.

Coming to the topic of science teaching in a college from my long experience, I have observed two aspects, which I would like to share with you. Firstly, the increasing trend of setting objective type questions might have diverted the students from the erstwhile practice

of intensive study to the trend of apparently more rewarding extensive superficial study, avoiding the details as far as possible. This defeats the very purpose of studying science subject and jeopardizes the scope of developing an analytic frame of mind.

Secondly, during the last twenty five years or so, the general trend of students taking up higher studies, has shifted from basic sciences to technical and professional courses. As a license to admission to some of such courses, the students are compelled to opt for science stream up to +2 level. But unfortunately, many of such aspirants lack the competence to excel in science subjects, either in the qualifying examination or in the entrance examination or both. The basic reasons seem to be (1) poor knowledge of Mathematics, which is essential for having a clear grasp of science subjects (particularly Physics and Chemistry); (2) lack of attraction and interest in such subjects because of the prevailing general perception of the students in the school level that science subjects are difficult to learn.

Thus, the cream of the students who excel in science subjects, go for technical/professional courses. Obviously, only a few good students along with the mediocre and the not-so-competent ones are left to take science subjects in the UG level.

The understanding of basic Mathematics and arousing of interest in study of science, lies most in the middle school level teaching, which needs improvement to attract students in this direction. It is my experience as a Physics teacher that lack of adequate and proper school level knowledge in Mathematics and Science, become a stumbling block for the students for understand the +2 level science courses, which is the launching pad to higher studies in science related areas. Actually speaking, the p resent trend of a section of parents, guardians and relatives to push the young students to courses which do not suit them and in which they have no interest, is another factor which should be given due consideration.

To ensure admission of better or more prospective students in the +2 or the under graduate level, I would like to suggest here that over and above the marks obtained in the qualifying examinations, sessional marks also may be included in the mark sheet. These sessional marks are to be awarded to a student on his/her round the year performance, to be monitored judiciously by a competent group of teachers concerned. Regular class tests/monthly tests/laboratory works/participation in class seminars and quizzes/participation in seminars and exhibitions organised by outside organisations etc. all may be included in the sessional mark, which would not be less than 20% of the full marks allotted for the subject/paper. These measures would, hopefully, ensure eliminating science phobia and thus help attracting students, who are thorough, hard working, having analytical and inquisitive mind and adaptability to diverse and challenging situations, to take up science subjects and have a successful career in science related areas.

For effective teaching and learning of science subjects one definitely need to know the basics which should be understood from a text book, written in simple, lucid language, not at the cost of the relevant details and providing some thought provoking questions at the end ofeach chapter. Students venturing into these questions will rekindle their inquisitiveness and help develop their analytical power. Here comes the role of a

well trained and dedicated teacher to help the students in taking a smooth and interesting journey through the text book as a whole. Another important aspect of proper science education is to provide laboratory experience with the scope of handling simple and interesting experiments to supplement the theoretical knowledge. Lack of proper laboratory facilities is another weak point of the prevalent from of science teaching. Even in so called educational hubs, some institutions set up as limited number of experiments as possible in the laboratory. Students are given to know that some four/five experiments (+2 level) would be done within 10/15 days time towards the end of the academic year and that most of them will score around 90% or more marks in the Practical Examination. Many of these superstars in practical papers may end up with 35% to 40% marks in the theory paper and on the strength of the overall marks in the theory paper and on the strength of the overall marks in the paper/subject, earn the right to stake a claim to study in the UG (honours) courses.

For attracting best students in basic sciences, primarily a balance should be struck between theoretical and practical knowledge imparted and the facilities provided to the students at the appropriate levels. There is absolute necessity of dedicated and well trained teachers in the school levels. Teachers (both in school and college levels) have to adapt themselves with the latest progress in their subjects concerned. Revision of theory syllabi as well as setting up of new and relevant practical experiments (discarding the outdated ones) from time to time, would be helpful in imparting a balanced and up to date knowledge of the subject concerned. Attractive and useful experiments and apparatus developedby eminentscientists / teachers / Research workers and available in our country should be adapted and introduced in the relevant levels of study of science. Eminent scientists may be invited by institutions to give popular lectures on interesting topics with demonstration along with students' participation. Such measures will attract students, in general, to take science subjects in +2 level and the science students, after successful completion of +2 level would come forward to take study of Basic sciences in the higher levels. This will set up a trend of attracting meritorious students to the basic sciences and in due time the existing void of talents in basic sciences will be filled up, at least, partially.

For an overall improvement in the science education scenario, it is absolutely necessary to attract qualified and talented youth to science teaching. To facilitate this, the sense of security has to be provided to the teachers, in general, and science teachers in particular, so far as financial and other facilities are concerned. Proper facilities for research work should also be there for teachers. Interactions between teachers of different institutions and group discussions involving students and teachers would help spread scientific temperament, in general, and provide the opportunity of sharing of latest information/developments in science related areas for all the stakeholders.

Last, but not the least, the attitude of the teaching community, as a whole, at every stage of science education will play the key role to attract the best talents in science education.

The science fraternity would expect the science teachers to act as a role models to arrest the present trend and give the science teaching, as a whole, a dynamic forward momentum in the desired direction.

LONG LIVE SHILLONG COLLEGE.

APPLICATIONS OF STATISTICAL TOOLS IN SCIENTIFIC ARENA

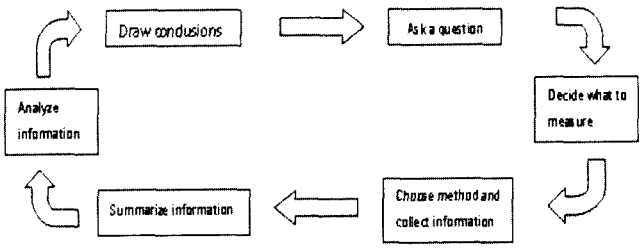
Sankar Goswami
Asstt. Professor, Department of Statistics,
G. C. College, Silchar, Assam.
Email ID: sankar_goswami@yahoo.com

Statistical techniques date to the 5th century BC. The earliest known writing on Statistics appears in a book of 9th century entitled Manuscript on Deciphering Cryptographic Messages, written by Al-Kadi. In this book, Al-Kadi provides a detailed explanation of how to use statistical techniques to convert encrypted messages into normal languages. This was the birth of both Statistics and cryptanalysis, according to the Saudi engineer Ibrahim Al-Kadi. Some people opine the origin of Statistics in 1663, with the publication of "Natural and Political Observations upon the Bills of Mortality" by John Graunt. The scope of the discipline of statistics broadened in the early 19th century to include the collection and analysis of data in general. Today, statistics is widely employed in government, business, and natural and social sciences.

The mathematical foundations of Statistics were laid in the 17th century with the development of the probability theory by Blaise Pascal and Pierre de Fermat. Probability theory arose from the study of games of chance. The use of modern computers has expedited large-scale statistical computation, and has also made possible new methods that are impractical to perform manually.

Statistics is the mathematical body of science of collecting, analyzing and making inference from data. Statistics is a particular branch of mathematics that is not only studied theoretically by advanced mathematicians but one that is used by researchers in many fields to organize, analyze, and summarize information. Statistical methods and analyses are often used to communicate research findings and to support hypotheses and give credibility to research methodology and conclusions.

We can divide the statistical methods into two parts viz. descriptive and inferential. Descriptive method summarizes population data by describing what was observed in the sample numerically or graphically; this is useful in communicating the results of experiments and research. In addition, data patterns may be modelled in a way that accounts for randomness and uncertainty in the observations. These models can be used to draw inferences about the process or population under studya practice called inferential statistics. Inference is a vital element of scientific advance, since it provides a way to draw conclusions from data that are subject to random variation.



"... it is only the manipulation of uncertainty that interests us. We are not concerned with the matter that is uncertain. Thus we do not study the mechanism of rain; only whether it will rain." Dennis Lindley, 2000.

Nowadays statistical techniques hold a central position in almost every field like Industry, Commerce, Trade, Socio-economic planning, Actuarial Sciences Physics, Chemistry, Economics, Mathematics, Zoology, Botany, Medical Sciences, Psychology, Astronomy etc..., so application of Statistics is very wide. It is worthy to mention that Govt. of India has designated 29th June of every year as National Statistics Day on the birth anniversary of Late Prof. P. C. Mahalanobis and in recognition with the notable contribution made by him in the field of economic planning and statistical development. Some fields of inquiry use Applied Statistics so extensively in scientific perimeter that they have specialized terminology. Let us discuss some of them.

Biostatistics (Also known as Biometry or Biometrics): The science of Biostatistics encompasses the design of biological experiments, especially in medicine, agriculture and fishery; the collection, summarization, and analysis of data from those experiments; and the interpretation of, and inference from, the results. A major branch of this is Medical Statistics, which is exclusively concerned with medicine and health.

Chemo-metrics: The science of extracting information from chemical systems by data-driven means. It is a highly interfacial discipline, using methods frequently employed in core data-analytic disciplines such as multivariate statistics, applied mathematics, and computer science, in order to address problems in Chemistry, Biochemistry, Medicine, Biology and Chemical Engineering.

Demography: The statistical study of human populations. It can be a very general science that can be applied to any kind of dynamic living population, i.e., one that changes over time or space. It encompasses the study of the size, structure, and distribution of these populations, and spatial and/or temporal changes in them in response to birth, migration, aging and death.

Data mining: An interdisciplinary subfield of computer science. It is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. The overall goal of the data mining process is to extract information from a data set and transform it into an understandable structure for further use. Aside from the raw analysis step, it involves database and data management aspects, data pre-processing, model and inference considerations, interestingness metrics, complexity

considerations, post-processing of discovered structures, visualization, and online updating. Energy Statistics: It refers to collecting, compiling, analyzing and disseminating data on commodities such as coal, crude oil, natural gas, electricity, or renewable energy sources, viz. biomass, geothermal, wind or solar energy, when they are used for the energy they contain. The need to have Statistics on energy commodities became obvious during the 1973 oil crisis that brought tenfold increase in petroleum prices. Before the crisis, to have accurate data on global energy supply and demand was not deemed critical. Another concern of energy Statistics today is a huge gap in energy use between developed and developing countries.

Engineering statistics: A combination of Engineering and Statistics. Some of the famous statistical techniques used in engineering are:

1. Design of Experiment: to formulate scientific and engineering problems using statistical models. In engineering applications, the goal is often to optimize a process or product by reducing cost of experimentation.

2. Quality control and Process control use Statistics as a tool to manage conformance to specifications of manufacturing processes and their products.

3. Reliability engineering which measures the ability of a system to perform for its intended function (and time) and has tools for improving performance.

4. Probabilistic design involves the use of probability in product and system design.

5. Time and Methods engineering use statistics to study repetitive operations in manufacturing in order to set standards and find optimum manufacturing procedures.

Epidemiology: The study of the patterns, causes, and effects of health and disease conditions in defined populations. It is the cornerstone of public health, and informs policy decisions and evidence-based medicine by identifying risk factors for disease and targets for preventive medicine.

Geographic information system (GIS): A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. In GIS, statistical tools are used to allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations

Astronomical Statistics: Astronomy is one of the oldest branches of statistical study; it deals with the measurement of distance, sizes, masses and densities of heavenly bodies by means of observations. During these measurements errors are unavoidable so most probable measurements are founded by using Statistical methods.

Psychological statistics: The application of Statistics in Psychology has of immense importance. Some common applications include perception, human development, abnormal psychology, personality test, psychological test, etc. ; where it is important to determine validity of a test, perform factor analysis etc.

Different types of parametric and non-parametric tests are there which can be used in many diversified fields of activities. There are some types of statistical analysis, viz. Bootstrap & Jackknife Resampling, Multivariate Analysis, Statistical Surveys, Structured Data Analysis, Structural Equation Modelling, Survival Analysis, etc. that have contributed significantly in Science & Research activities. Prof. Bowley has rightly said, "A knowledge of Statistics is like a knowledge of foreign language or of algebra; it may prove of use at any item under any circumstance."

"FIGURES DO NOT LIE, LIERS FIGURE."

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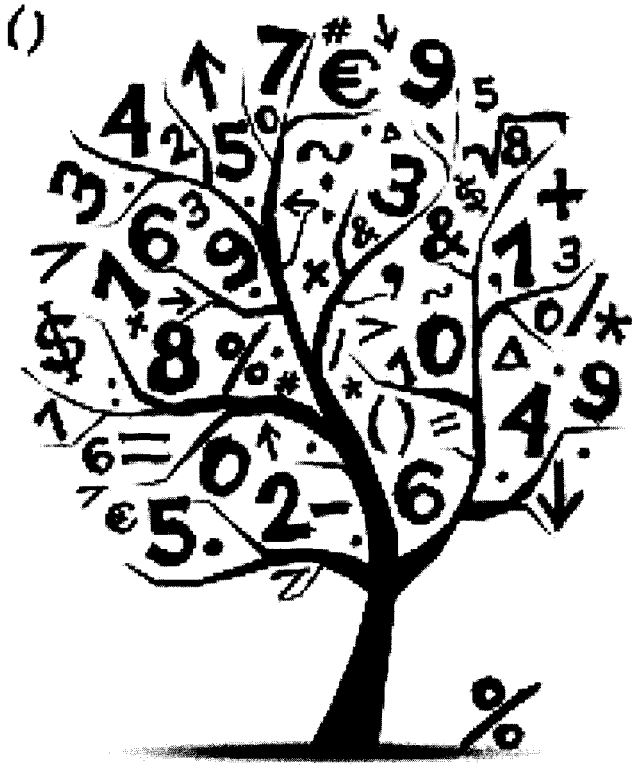


ROLE OF A TEACHER IN SCIENCE EDUCATION

Mrs. E. N. Dkhar
HOD (Physics)
Shillong College

As science teachers, we must remember that we are the catalyst for change. The changes required are conceptual and cultural. The changes must empower individuals to transcend the typically over-learned ways of thinking (or non-thinking) about the role of science education, to transform mental models of the roles and goals of students and teachers in the learning environment, and to translate new understandings about inquiry and meaningful learning into actual habits of practice.

The change we speak of must be systematic -- occurring simultaneously across several levels including individual, small community, and broader community. These changes are absolutely necessary before the overarching goal of science education - scientific literacy for all. For today, increasingly complex scientific and technological issues challenge our global society. The present quality of life is, and in the future will continue to be, affected by such issues both old and new. Yet the models of science education that widely persist in schools across the grade levels (including the college science classroom) are inadequate for developing the knowledge needed to tackle those problems. Those models largely fail to truly engage most students in the learning process; their consequences on student outcomes are disastrous. Students not engaged in the learning process leave with little more than shallow understandings, weak connections between big ideas, trivial knowledge, unchallenged naïve conceptions of how the natural world operates, and an inability to apply knowledge in new settings. As a result, students do not develop the ability or propensity to become self-regulating learners or inquirers.Science teacher educators, therefore, must facilitate the cognitive departure by their students from traditional models of teaching and learning of science - models that are no longer valid in a society confronted with exponential advancements in information and technology. The science teacher educator must also help his/her students to carefully consider what they will value in the learning community they seek to establish. For many prospective and practicing, science teachers should invoked radically new ways of viewing the teaching and learning of science and must be adopted to meet the new demands in science education. The role,.

therefore, of the science teacher educator is to perturb comfortable, over-learned views about schools and schooling in hopes of promoting conceptual changes within individuals, across small communities of learners, and across the broader community of people contributing to a program of education.

Teachers should also see that there is a constructive learning environment. That description includes one wherein:

1. Students are given the opportunity to communicate their understandings with other students, to generate plausible explanations for phenomena, to test, evaluate and defend their explanations among their peers, and actively engage in the social construction of knowledge - all of which are reflections of the nature of science.
1. Students are provided frequent opportunity to identify their own learning goals, to share control of the learning environment, and to develop and employ assessment criteria within the learning environment.
2. The environment of the classroom is conducive to inquiry. That spirit of inquiry includes the freedom for students to question the operations of their class.
3. Students must have the opportunity to experience the tentativeness of scientific knowledge. That is, students must understand that scientific knowledge is theory-laden and socially and culturally constructed.

The findings of the studies discussed above provide clear guidelines for the science teacher educator's role in establishing an inquiry-based learning community within the teacher education program. That is, he or she must create and model them as follows:

1. A classroom environment that predisposes students to accommodate Ambiguity and Flexibility.
2. A learning environment that values collaboration over competition and cooperation over opposition.
3. Authority structures within the classroom consistent with student centred approaches toward learning.
4. Attitudes of collegiality that is palpable within the classroom. This is fostered by active participation with professional societies, student organizations, and whole-class endeavours.
5. A classroom environment reflecting the importance placed on student roles, responsibilities, and learning.
6. A classroom learning environment extending beyond the classroom walls.

In my knowledge, I feel that pre-service and in-service teachers can express their ideas, test their developing theories and apply their understandings of practice in such environments. When students and teachers can do these things, efforts to improve and advance science education are strengthened, classrooms and teachers will be transformed, and we may begin achieving the education reform and goals we all seek.

"IT IS THE SUPREME ART OF THE TEACHER TO AWAKEN JOY IN CREATIVE EXPRESSION AND KNOWLEDGE". ~~~~ Albert Einstein

MAKING SENSE OF UNDERSTANDING SCIENCE AND HANDLING TECHNOLOGY

Dr. Deborah L. Buam
Department of Chemistry,
Shillong College

Science is an age-old endeavor to bring together by means of systematic thought the perceptible phenomena observed in the world around. We live in an age of technical development and the progress of science was well appreciated by those who understand and even the casual observer who makes use of technical applications of science. The whole of science is nothing more than a refinement of everyday thinking and so science does not stand still and there is always something new and something more to learn. Scientific research had indeed reduced superstition by encouraging people to think and view things in terms of cause and effect.

It is a well-established fact that the long-term effects of science and technology cannot be foreseen accurately and scientists as human beings have a particular duty to assess potential risks and hold responsibility not only to develop new technology but also to deal with risks thereof one thing is clear that even when scientists perceive possible implications and potential risks arising from their researches it is often difficult for them to know with absolute certainty and take responsible action. Chemical products as we are all aware have an environmental impact, it took years for mankind and the scientific community to observer and understand the hazard of chemicals and to Find a solution to such adverse consequences induced by mankind on nature. Nevertheless the recent advancements will not be overrated if the fundamental problems of science are kept lingering in the mind. The fact remains that everyone is aware of risk factors through practical use of technology which one needs to give thought of the implications.

It is a fact that no country would deny that it does not possess chemical weapons. It is known that the United States transferred all of its captured chemical weapons to five German munitions depots for decontamination, detonation, and incineration. Under the provisions of the Chemical Weapons Convention, an accused state must allow a thorough investigation failing which the state bears the stigma that comes on being identified as a potential possessor of chemical weapons. Many of the countries are known to have signed the Chemical Weapons Convention. Now that it is in force, the treaty, and its implementing body, the Organization fo the Prohibition of Chemical Weapons, does its job to reduce the number of states with chemical warfare capabilities. All countries that are party to the convention are required to declare past and present chemical weapons research, development, production, and stockpiling, although their declarations will remain confidential, India has

admitted to having such a program. The Chemical Weapons Convention, which concluded in 1992 after more than a decade of negotiations, has flagged as a major milestone in the history of arms control and disarmament.

Unfortunately, if there is anything that scientists cannot do is to stop or dictate terms about misuse of technology, as mentioned earlier, technology is not always handled by only those who understand but it goes to hands that use not only for constructive means but destructive as well.

India is known to have possessed a chemical weapon program yet it has declared it for defensive purposes. There are evidences of chemical-weapon programs in many Asian countries like China, Pakistan, North Korea, and Taiwan and they appear to have developed chemical weapons in response to regional tensions. Burma, on the other hand, apparently wanted chemical weapons for domestic use which may encourage other governments to believe they would not be criticized if they initiated chemical weapons programs provided they mean it. All countries the world over, the Middle East countries, European countries and United States too have not denied the truth of having developed chemical weapon program, but what matters most is the purpose behind.

The problem of environmental pollution on earth and sea is becoming more acute in tropical countries pushing a large population into poverty, temperature change, dryness and lack of fresh waters. We are well aware of the effects of chemicals on the earth and all around it but little is known of what is going on in the deep waters, and even more of under the seas . Such dangerous weapons, of course, could not be openly dumped at sea today, but the decision to do so in the era between the end of World War II and the dawning of the age of Environmental consciousness is understandable, because from the 1940s to the 1960s, the level of security and consciousness about the environment was less than it is now, as noted by Greg Williams, the national spokesperson for the Kentucky Environmental Coalition, An organization that works for the safe disposal of chemical weapons. Enough of international agreements were made to ban dumping of wastes at the sea yet such wastes have often been gone to the third world countries for disposal and even strangely enough, the Chemical Weapons Convention, does not cover sea-dumped chemical weapons, in fact, it makes a clear exception for them. Alexander Kaffka, a researcher at the Russian Academy of Sciences, Chairman of the Conversation for Environment International Foundation, and editor of Sea Dumped Chemical Weapons once added, "There were some important safety rules envisaged at the time, for instance, to dump only in deep waters and far from the shores. But the rules were often broken, which led to the most dangerous kind of dumping-at shallow depths, in straits, and in areas of active fishing." Even though the idea of scientists and some respected international organizations like the Chemical Weapons Convention, that it is best to leave the underwater sites alone, especially if they are in deep waters, yet one needs to look in the light of environmental implications of the issue as times are changing and people are now more conscious of environment.

The solution to environmental impact, of long-term effects of technology, of dumping chemicals on land or in the deep seas, in turn, lies in those who handle scientific research and technology. Experimental research is subjected to strict ethical code promoting only the alternative attempts with quality assurance that would preserve animal and human rights. It would be exciting to see that funds may be enhanced and made available not only for applications of modern scientific techniques but more importantly towards investigating the possible long-term effects on living species and environment and find meaningful solutions. It is also high time that the national and international governments need to be alert and take a proactive role as to where the entire research and development fund goes. It is an absolute truth that no country would foolishly spend enough money for the development of chemical, biological weapons or atomic bombs if its use goes only towards destructive means.

GENETICS, TECHNOLOGY AND SOCIET
YDNA FINGERPRINTING: THE IDENTIFICATION TEST

Mrs. D.N. Shabong
Associate Professor
Department of Zoology

DNA is the master molecule of all life forms. It constitutes the blueprint of every living organism through which characters are passed generation to generation. However every living organism differs only due to nucleotide sequences of chromosomes. The nucleotide form codes, therefore this coded genetic information can be profiled to produce the identity card of any organism. The complicated technology that facilitates the identifications of individuals at genetic level is known as DNA-FINGERPRINTING. This genetic analysis is based on identifying tiny segments of the hereditary material which exhibit variation in the length of repetitive DNA or nucleotide sequence which testify the unique molecular signature which cannot be altered. These polymorphisms in human DNA serve as the basis for the DNA fingerprinting technique. The technique was discovered by Alec Jeffreys (1985, 86) at Leicester University, UK.

DNA Fingerprinting is now used for a wide variety of applications, from identifying individuals for paternity to forensics and

Every year in court cases all over the world, the ability to establish a person's identity is essential for a just decision. In a criminal case, if there was no identifiable fingerprint left behind at the crime scene, there was no case. Today genetics has come to the rescue of the courts, a test (DNA fingerprinting) has how been developed that provides hundred percent positive idenfication.

In forensics: The use of DNA analysis in forensics is making it harder and harder to get away with many crimes. The technique involves a comparison between the DNA fingerprint obtained from cells at a crime scene with a DNA fingerprint from cells provided by the suspect. It is now a simple matter to isolate DNA from tissue left at a crime scene, a splattering of blood, some skin left under a victim's fingernails or even the cells clinging to the base of a hair shaft. A variety of techniques can be used to determine the likelihood that the sample came from a suspect in the case.

Accidents or homicide victim unidentifiable from their physical features can be identified

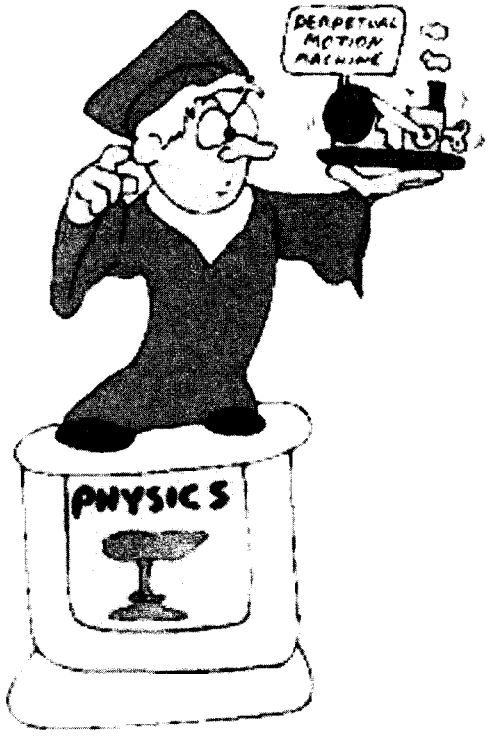
Provided typable DNA is isolated from the victim's remains and is matched with DNA, perhaps from hair roots obtained from his or her hairbrush.

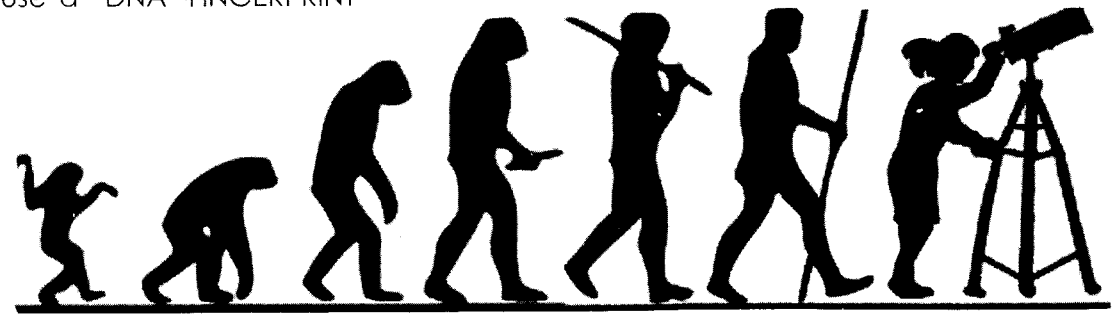
For paternity determination:- DNA fingerprints of the mother, child and alleged father are compared. In this case, one half of the bands in the child come from the mother and the other half from the father. All the paternal bands in child's DNA fingerprint must matched with the alleged father for positive paternity identification.

For reuniting the lost children:- DNA fingerprinting technique helps in reuniting the lost children with their respective parents or vice versa who were separated during war, violence or natural disasters. By matching the DNA profile of the parents with that of lost children, children have been reunited with their families.

There are many other applications of DNA fingerprinting solving problems like immigration cases, counseling for genetic diseases etc.

The wide application of this technique, providing solutions to many problems and disputes is all because a "DNA -FINGERPRINT" represents a "SNAPSHOT" of the genome of an individual, allowing it to be distinguished from those of other individuals in the population.





SCIENCE AND ITS FOUNDATION: A PHILOSOPHY OF SCIENCE PERSPECTIVE

Dr. B.P. Tripathi
Dept. Of Philosophy,
Shillong College,Shillong-3

Science is considered to be the pulse of a nation in day-to-day life. As the evolution of man from ages took place, he began to adapt to science. He started finding reasons to the daily activities and this was the beginning of the scientific era. Science civilized man and made him the king of all creatures. Science helps a man to think logically and analyze the daily events rationally.

Primitive mean found it difficult to combat nature's fury and stated worshipping various forces of nature. He started believing in supernatural powers and due to ignorance failed to explain various natural phenomena. This ignorance led him to superstitions. Today, we are equipped with scientific explanation of different phenomena that used to be described as mysterious before.

Science is its real sense means 'systematic study'. Through this systematic study one tries to understand the laws of nature. And then finally apply this acquired knowledge in new discoveries, inventions for the benefit of mankind and progress of civilization. The process of civilization is largely dependent on advancement in scientific knowledge, or in other words advancement of science. To know science is to know its basis, foundations on which it is based for any kind of discovery inventions or investigation. We should also try to know and understand what is the real difference between science and non-science are.

Fundation of Science:

To know science and how it works or what are its foundations, the study of philosophy of science become indispensable. Philosophy of science, a branch of Philosophy is an entire field of rigorous academic study that deals most importantly with what science is and how it works and the logic through which we build or derive scientific knowledge. As a branch of Formal philosophy, science is almost synonymous with the scientific method, it is the philosophy and ideal that scientists hold and they believe they should ascribe to.

The central questions about science are:

a. What are the aims of science, and

b. How should one interpret the results of science?

According to the scientific realists, science aims at truth and that one ought to regard scientific theories as true or approximately true, or likely to be true. But for Scientific antirealist or instrumentalists, science does not aim at truth. They hold the view that scientific theories are instrumentally useful, but not true.

Philosophy of science is dedicated to questions about science and the scientific method. It is concerned with all assumptions, foundations, methods, implications of science, and with the use and merit of science. Philosophy of science is not an attempt to do science but to know how science is done and why science is to be considered a good method.

The Demarcation Problem is yet another problem which is discussed in Philosophy of science. It refers to the distinction between science and non-science (Pseudo science too). According to Karl Popper, the demarcation problem is the central question in the philosophy of science. However, nothing concrete has been experienced and has been accepted so far. To some philosophers of science, the problem is insolvable or uninteresting. For the logical positivists, science is observational whereas non-science is non-observational and therefore, meaningless. It is true that science deals only with appearance (observational) but to say non-observational as meaningless is logically untenable.

Karl Popper in his scientific epistemology Falsificationism argued that the central property of science is its falsifiability. According to him, falsifiability is the demarcation criterion distinguishing the scientific form unscientific. Popper states that evidence can only be used to rule out ideas and not to support them .He asserts that scientific ideas can be tested through falsification, and never through a search for supporting evidence. It means that what is unfalsifiable can be classified as unscientific and that the practice of declaring an unfalsifiable theory to be scientifically true is pseudoscience (non-science).

Falsifiability is also sometimes taken as "litmus test" of science which means a claim can be falsified or shown not to be true. For instance, Atomic theory could be falsified by showing a chemical reaction that was not stoichiometric, on the other hand, supernatural explanations (non-observational type) cannot be falsified as by definition proponents of supernatural explanations will put themselves outside the realm of actual testing.

After having discussed briefly the problem of science in distinguishing science from non-science, it does not mean science suffers from some defect or there is anything empirically impossible for it to do. But a question always remains satisfactorily unanswered that: what is the basis of science with the help of which it begins its investigation and finally reaches to discovery of a law or invention of a thing? On what does it rely? It is the normative principles or the principles other than Normative in nature on the basis of which science is done? What are the grounds of scientific reasoning? What are its methods/Procedures?

Science seems to rely on certain methods (Procedures) that appear to be indispensable for the valid scientific reasoning. Firstly, Empirical Verification one of the sources for building knowledge through experience. It is based on the assumption that what is observable is reliable. Science relies on evidence to validate its theories and models and the predictions implied by those theories or models at any point of time or place should be in agreement with observation. It suggests the reality only observational in nature and thus empirically verifiable. Observation does

not mean a simple observation; it means observation with a purpose including analysis. Analysis is the activity of breaking an observation or theory into small parts or simpler concepts in order to understand it. Analysis is as essential to science as it is to all rational activities. Observation means to have a proper understanding about the thing or concept or the theory being studied. For example, in order to describe mathematically the motion of a projectile, is made easier by separating out the force of gravity, angle of projection and initial velocity. This is how a suitable theory of motion can be formulated. After such analysis observation discovers a fact and helps science to make further prediction on the basis of it.

Secondly, science bases its claim on the notion of Induction. In Inductive reasoning we pass from observed (or known) cases to unobserved (or unknown) cases on the basis of our past experience. After having observed all the particular cases about a fact (or phenomenon) a general conclusion is inferred that seem to fit with all the time to come. Inductive reasoning maintains that if a situation holds good in all the observed cases, then the situation holds good in all the time to cases (both observed and unobserved). For example, how can a scientist state that Newton's Third law is universally true? It is only possible after completing a series of experiments that support the Third law, and in the absence of any law in the contrary, one is justified in maintaining that the Third law is universally true as one is justified in saying that the Law holds in all the cases. If induction were not regularly correct, no science or technology would be possible. In this context one thing must be made clear that an induction is based on observation. If observation is correct then a correct general conclusion can be inferred.

Thirdly, Induction is empirically verifiable, but it is not exactly true with Deduction. Like Induction, Deduction is also a kind of reasoning where the process of moving logically (inferring) is from premise to conclusion. For example, if one knows the current relative position of the moon, sun, and earth, as well as exactly how these move with respect to one another, we can deduce (infer/know) the date and location of the next solar eclipse. Both Induction and Deduction serves as the basis for obtaining any kind of scientific knowledge.

Fourthly, after Inductive and Deductive reasoning, It is hypothesis which plays a vital role in obtaining and planning scientific knowledge. Hypothesis is a provisional supposition, assumption with sufficient justification. Hypothesis without sufficient justification (incompatible with any empirical observation) are to be eliminated. It is used by both a philosopher and a scientist to make testable predictions. For Karl Popper, any hypothesis that does not make testable predictions is simply not science. Such a hypothesis may be valuable or useful, but it cannot be said to be science. According to WV Quine, empirical data are not sufficient to make a judgment between theories. Formation of hypothesis is done on the basis of observed empirical data and therefore, a theory (judgment) can always be made to fit with the available empirical data. All theories or judgment reached at may not be of equal value. To avoid ambiguities, scientists often use Occam's Razor as their guiding principle. Occam's Razor, a principle of Parsimony, refer to distinguishing between two hypotheses either by 'shaving away' as an unnecessary assumption or 'cutting apart' two similar conclusion. It states that all things being equal, one should prefer a simpler explanation

over a more complex one. In other words, among competing hypotheses the hypothesis with the fewest assumptions should be selected. However, science prefers the simplest explanation that is consistent with the data available at a Given time, but the simplest explanation may be ruled out as a new data become available. Occam's razor formula suits well with the case of working hypothesis.

Ancient scientist advocated the rising of the sun in the morning as evidence that the sun moved. Later scientists interpreted that the Earth is rotating. It means that observation of a fact (or an object) may vary from person to person place to place and time to time. But it is the subjective aspect of observation. Observation, in its objective aspect, used to determine the acceptability of hypothesis within a theory which has been formulated with a definite purpose. Observation and formation of hypothesis go together. For Thomas Kuhn, observations always rely on a specific paradigm, and that it is not possible to evaluate competing paradigms independently. By 'Paradigm' he meant essentially a logical constant "portrait" of the world, one that involves no logical contradictions and that is consistent with observations that are made from the point of view of this paradigm Kuhn says acceptance or rejection of some paradigm is a social as much as a logical process. According to Kuhn, a paradigm shift will occur or as new paradigm is chosen when a significant number of observational anomalies in the old paradigm have made the new paradigm more useful. It is also because the new paradigm does a betterJob of solving scientific problems that the old one. Scientific understanding derives from observation, but whether it is acceptable to scientific statements is dependent on the related theoretical background or paradigm as well as on observation.

After having discussed so much about science and its ultimate basis on or through which it derives scientific understanding are the Logical assumptions, well regulated observation and hypothesis. Yet, despite the diversity of opinions, Philosophers of science can largely agree on one thing, there is no single, simple way to define science.

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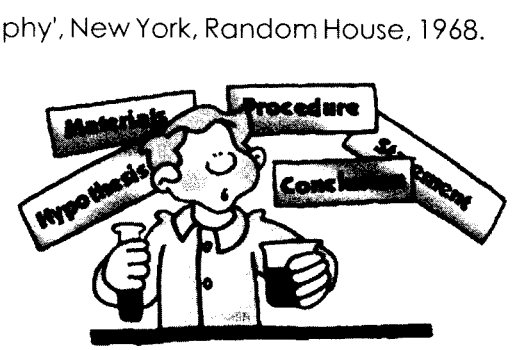


KNOWING ABCD OF SCIENCE IS THE FOUNDATION OF ITS TECHNOLOGY: Forensic Entomology

Dr Lucy Mary Jyrwa
Department of Zoology

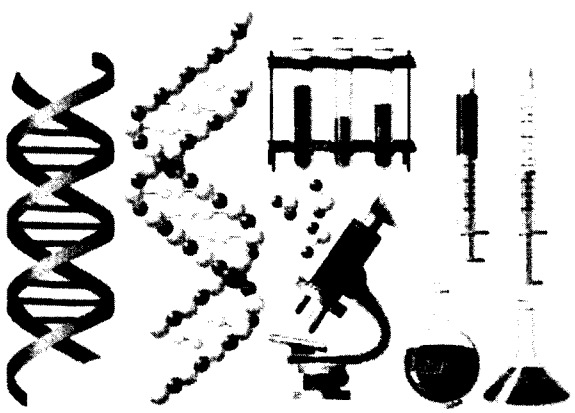
The influence of science on people's lives is growing. Modern science has developed a method based on a "frame of thinking" which has proven to be so fruitful that it is applied in all possible fields including human society and the notion of health and illness. One such application of science which is for the benefit of human kind that depends simply on the life history of an insect is forensic entomology. Forensic entomology is the interpretation of entomological evidence to help resolve a criminal investigation. The insects that have been most extensively studied in relation to their forensic uses are the blowflies--members of the Calliphoridae fly family (carrion flies, bluebottles, green bottles, cluster flies,)-in particular their larvae or maggots, because, they are the insects most commonly associated with corpses. They colonise the body most rapidly after death and in greater numbers than most other insect groups. They usually provide the most accurate information regarding the post-mortem interval (PMI) which is the time that has elapsed since death, a major objective in forensic entomology. Blowfly infestations of human bodies are a natural outcome of the flies' role in the environment as primary decomposers. The larval infestations might look gruesome, but they are a vital component of the natural recycling of organic matter and, on human bodies, they can provide vital clues to the timing and cause of death.

Adult blowflies are well adapted to sensing and locating the sources of odour of decay, so cadavers are quickly found. Eggs are usually laid in the natural orifices (e.g. eyes, nose, mouth, ears) or other dark and moist places, such as the folds of clothes or just under the body. Eggs hatch into first instar larvae that grow rapidly, moulting twice to pass through second and third instars until they finish feeding. Depending on the species, they pupate on the body or move away to find a suitable site. They may move many metres before burrowing into the soil or under objects such as rocks and logs or, if indoors, under carpets and furniture. The larva then contracts and the cuticle hardens and darkens to form the barrel-shaped puparium, within which the pupa metamorphoses

into an adult fly. When the fly emerges, the empty puparial case is left behind as long lasting evidence of the insect's development.

Forensic entomologists use precise methods to collect and present the evidence correctly--a vital precursor to accurate interpretation. They determine facts about the location of the dead body and its accessibility to flies, particularly blowflies at the scene of the crime. The largest and therefore oldest maggots are the most important specimens but the complete ranges of maggots present are sampled because they may shed light on different aspects of the investigation. Taxonomic identification of the insects found on corpses is essential to the reconstruction of events surrounding criminal cases involving death. Systems of classification of biological organisms are used to facilitate their identification. Scientists then determine the age of the specimens to provide evidence as to when the female flies first found the dead body and laid their eggs--the minimum estimate of the post-mortem interval. This can be taken as the latest time by which death must have occurred. The estimation of maggot age relies on detailed knowledge of the fly lifecycle and the factors that influence it. The rate of development of blowflies is directly dependent on the ambient conditions, particularly temperature. Between upper and lower thresholds, which vary between species, the higher the temperature, the faster the insects will develop; the lower the temperature, the slower they will develop. Toxic substances in or on a dead body feed by the larvae can also affect their rate of development. For example, cocaine and heroin significantly increase the rate of development of larvae, thereby affecting the accuracy of post-mortem interval estimates if not taken into account. In contrast, insects may take much longer to colonise and decompose a body if it is wearing clothes permeated with lubricants, paints or combustibles. In either way, forensic entomology can still approximately predict the time of death of the victim.

Forensic entomology can contribute a wealth of information in solving crime cases and despite 150 years of use, forensic entomology is still a young discipline which still needs to be perfected in combination with other technology like DNA technology. Thus, forensic entomology provides an open door for young minds to foray and contribute to this field of science.



Emergence of science and technology in the modern world

By Sunshine D. Kurbah
B. Sc. Chemistry, pass out student 2011,
Shillong College

In the modern world, the importance of highly specialized scientific and technical education is well recognized, and the improvement of each and every sphere of life continued with the progress of science and technology.

Science originated from the latin word scientia, meaning knowledge. This knowledge is originally in the form of testable explanation and prediction something relevant to the universe.

With this knowledge human life was improving day by day, inventing something new which makes himself easier and reliable to approach new experiment and to prove theoretical evidence. Some inventions are so ubiquitous that it's difficult to imagine they started as an idea scribbled on paper and then a patent application submitted. Let examine briefly about the evolution of Carbon nanotube in the field of science and technology, it's properties and how they are used full to man kind.

CARBON NANOTUBES:-

These are the allotropes of carbon with a cylindrical structure, capped on the ends with buckyballs or open ended and composed entirely of sp2 bonds. Because of it unique properties and wide range of application, seemingly to be a materials of the future generation.

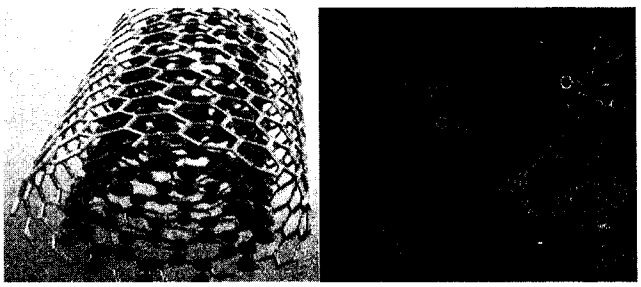


Figure: Carbon nanotubes structure.

Properties:-132,000,000:1n Length-To-Diameter Ratio, diameter of 3 to 9 nm, efficient electrical conductors. Can act as both thermal conductors and thermal insulators. Toxicity:- Research is still in the early stage, In rodents, carbon nanotubes have been found to cause several lung issues. The needle-like shape of the fibers is similar to that of asbestos.

Applications:-

Electrical:-Field emission in vacuum electronics, application in electrodes, capacitors.

Energy storage:- Lithium batteries. Hydrogen storage

Biological:- sensors, AFM tipsDNA sequencing.Electrical Application: Field Emission Display (FED)

- Uses electron beam to produce color images (FED)

- Traditionally cathode ray tubes are used but recently more focus on using carbon nanotubes

- NASA is researching this technology to use in space exploration.

Energy Storage: Lithium batteries

- Nanotubes have the highest reversible capacity of any carbon material for use in Lithium ion batteries

- Nanotubes have intrinsic characteristics desired in material used as electrodes in batteries and capacitors

- Nanotubes are outstanding materials for super capacitor electrodes

- They also have a number of properties including high surface area and thermal conductivity that make them useful as electrode catalyst supports in Polymer Electrolyte Membrane (PEM) fuel cells.

Energy storage: Hydrogen storage

Single-walled carbon Nanotubes can store hydrogen

Nano tube technology will meet the challenge of storing hydrogen and releasing them adequately in hydrogen fuel car in future

Physisorption and chemisorption e mechanisms used for hydrogen storage in carbon nanotubes

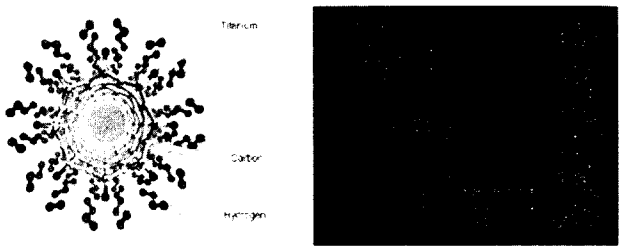


Fig:2.Top view and side view of the assembled CNT-DNA system

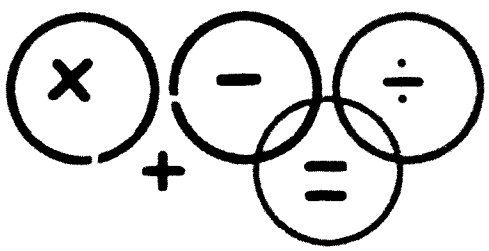
Biological applications: DNA sequencing

Nanotubes fit into the grove of the DNA strand

Apply voltage across CNT, different DNA base-pairs give rise to different current signals . With multiple CNT, it is possible to do parallel fast DNA sequencing Nanotube speakers;

Thin carbon nanotube films can act as speakers. New generation of cheap, flat speakers

Transparent, flexible, stretchable, and magnet free.




Science Fair
EVERYTHING UNDER THE SUN
A+

Why Mathematics...?

Mr. M. W. Synrem
Assistant Professor, Mathematics Department
Shillong College, Laitumkhrah Shillong 793003
Phone No.: (M) 09436303017, (O) 03642224903
Email: wanridor_syne@rediffmail.com

Why Mathematics...? **Mr.M.W.Synrem**

Assistant Professor, Mathematics Department, Shillong College

Everybody moans at the very mention of "maths". People think that the world is divided into two kinds of folks. The "brainy" lot who understand mathematics but are not the kind of people who wants to meet at parties.....and the rest of us!.....

But all of us need to understand maths to some extent. Without mathematics, life would be inconceivable. We need maths when we go shopping, check our bills, manage household finances.....and run our business. We need maths to build our houses.....insure our cars, do our banking. We need maths to make maps so we can find our way around cities.....travel round the world, even go out into space!

Thus mathematics is the engine that runs our industrial civilization. It is the language of science, technology and engineering. It is essential for architecture and design as well as economics and medicine....Even art relies on mathematics to some extent.

The ability to deal with mathematics does require a special talent and skill- like any other field of human endeavour, such as dancing. Just as an accomplished ballet performance is sophisticated and exquisite, so is mathematics in its essence very elegant and beautiful.

But even though most of us cannot become fully-fledge ballet performers, all of us know what it is to dance and virtually all of us can dance. Similarly, all of us should know what mathematics is about, and be able to understand and handle certain basic steps.....Fear of maths is like fear of dancing.....Both are overcome by a little bit of dancing.....Music is the pleasure the human experiences from counting without being aware that it is counting.

Counting.....

At school children learn to count, to calculate and to measure. Once they have been learned, these techniques may seem "elementary". Bur for the learners they are full of mystery. The naming of numbers becomes an incantation, especially when we get to the bigger ones. Counting to a hundred becomes tedious, but getting to a thousand is like climbing a

mountain! What is the klast number, the biggest one of all?.....if there isn't such a thing, then what is there at the end?....

How do we name the numbers, as we call them out one after another? Perhaps just a few numbers are enough. Some animals can recognize different collections upto five or seven-beyond that it's just "many". But if we know that numbers go on continuously, we can't just keep inventing new names indefinitely as we go along.

The best way to systematize naming and counting is to have a ""base", a number that marks the beginning of counting again. The simplest base is just two. For example, the Gumulgal, an Australian indigenous people counted like this: 1=Urapon, 2=Ukasar,3=Urapon-Ukasar,4=Ukasar-Ukasar,5=Ukasar-Ukasar-Urapon..... This may seem primitive and tedious.....but the base two in the form of 0's and 1's...is built into digital computers as the foundation of all their calculations.

The fingers of the hands are useful for defining bases. Some systems use five, more common is ten. But many other bases can be used. The old British currency had several: twelve (pence per shilling) and then twenty (shillings per pound) and even twenty-one (shillings per guinea). Shop assistants need to keep reckoning books by their sides. And when people bought in instalments, they might be told that their living room suite cost 155 guineas or 104 weekly payments of one pound, fifteen shillings and seven pence-half penny.

The base twenty (fingers and toes) is also common. The Yoruba used this, employing subtraction for the larger numbers within the base. They had different names for the numbers, one (okan) to ten (eewa). From eleven to fourteen they simply added. So eleven became "one more than ten" and fourteen "four more than ten". But from fifteen onwards they subtracted. So fifteen became "twenty less five" and nineteen became "twenty less one". The base twenty still survives in French, where eighty is "four-twenties" and nentynine is "four-twenties-nineteen". Those who deal with computers use bases built on two. So no single base is best. We can think of a number system as designed with diferrent attributes: easy to remember, convenient in naming, useful for calculating, etc. Once the grouping or base for a number system had been developed, it allowed the four basic functions of arithmetic.....Addition, Subtraction, Multiplication and Division.Written Numbers....

It is possible to count effectively in a culture with no writing. But calculating then requires much memory and special skills. As writing spread among civilizations, different systems, some quite sophisticated, emerged. The Aztecs used a system based on 20, with four basic symbols.

1 was represented with a blob designating a maize seed pod 20 was represented with a flag, 400 by a maize plant, 8000 was symbolized by a maize dolly

The Mayans' numbering system had only three symbols....a large dot was one, a bar was five and a snail's shell was zero. For example represent 3, == represent 10 and so ººº represent 13, Ö represent 20.

The Ancient Egyptians (c. 4000-3000 BC) used a pictorial script (hieroglyph) to write down their numbers.

1 10 100 1000 10,000 100,000

1,000,000

10,000,000

The Babylonians (c. 2000 BC) used a system based on 60 and its multiples, with the following symbols:

1 10 60 600 3600

Later, they evolved a system based on only two values:

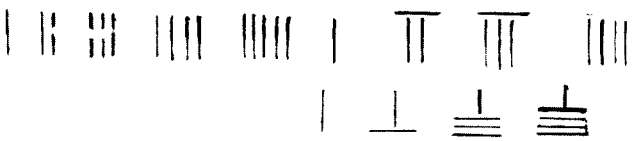
For 1 (or 60 depending on its position)

and  for 10. So 95 would be written as:

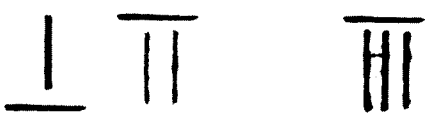
95= 60(I) + 35 :

The Babylonian sexagesimal system has survived to this day. Circles have 360 degrees. Hours have sixty minutes. Minutes have sixty seconds.

The Ancient Chinese (c. 1400-1100 BC) used a base 10 system of numbers with symbols for one to ten, a hundred, a thousand and ten thousand. Later around the 3rd century BC, the Chinese developed a form of numerals using straight lines (or rods), representing one to nine, which could be placed either upright or horizontally.



Normally, the uprights were used for units and hundreds and horizontals for tens and thousands. So 6708 would be written as :



With the blank space standing for "zero".

The Chinese made the great invention that put written symbols in a different world from the spoken names of numbers. This was a system of "place-value". The meaning of a number, as an expression of quantity, depended on its place in the string of numbers. Thus "2" could mean two, twenty or two hundred, depending on its location. This made it unnecessary to name the higher bases- in "234" we know that the 2 means 200

The Indians developed three distinct types of number systems- The Kharosthi (c.400-200 BC) used symbols for ten and twenty, and numbers upto one hundred were built up by addition. The Brahmi (c300BC) used separate symbols for the digits one, four, to nine and ten, a hundred a thousand and so on. The Gwalior (c. 850 AD) had symbols for numbers one to nine as well as for zero.

The Indians were very comfortable with high numbers. The classical Hindu text give names to numbers as large as 1,000,000,000,000 (parardha)!

The ancient Greeks (c. 900BC 200AD) had two parallel systems. The first was based on the initial letters of the names of the numbers. So five was symbolized by the letter pi, ten by the letter delta, one hundred by the antique form of letter H and so on. The second system which emerged around the 3rd century BC, used all the letters of the Greek alphabets and three from the Phoenician alphabet making a total of twenty seven numerical symbols. The first nine letters of the alphabet signified the number 1 to 9, the second nine letters were used for tens from 10 to 90, and the last nine letters described the hundred from 100 to 900.

The Roman system (400BC-600AD) had a total of seven symbols: I for 1, V for 5, X for 10, L for 50, C for 100, D for 500 and M for 1000. The numbers are written from left to right with the largest quantities placed at the left and added together to obtain the designated number. So LX is 60. For convenience, a smaller quantity on the left was interpreted as a subtraction. So MCM means 1900.The Roman numerals, still used today for ornament, were not suitable for doing rapid calculations.

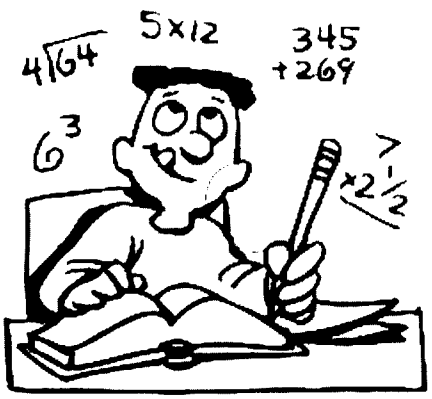
The use of the alphabet for numbers enabled the rise of a highly developed art of divination called "gematria". Given any word or particularly a name, one would rearrange the letters to form a number and then scrutinize that for its quality and meaning. Anyone whose name yielded 666 (the Biblical "number of the Beast") was obviously a "Bad Thing".

The Muslim civilization (650 AD-present) developed two sets of numerals. The sets were similar, but one was used in the eastern part of the Muslim world (Arabia and Persia), while the other was common in the western part (the Maghrib and Muslim Spain). Both contain ten symbols from zero to nine.

Eastern set: ١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩

Western set: 1 2 3 4 5 6 7 8 9 0

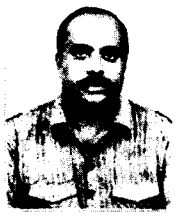
The eastern set is still used throughout the Arab world. The western set is what we now know as "Arabic Numerals"- the system we all use today.



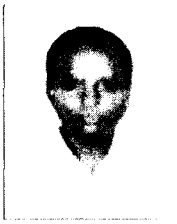
NEPALI DOCUMENT CLUSTERING USING SELF ORGANIZATION MAP

Sunita Sarkar,
Assam University, Silchar
Sunitasarkar@rediffmail.com

Arindam Roy,
Assam University, Silchar
Arindam_roy74@rediffmail.com



Bipul Shyam Purkayastha
Assam University, Silchar
Bipul_sh@hotmail.com



Abstract

The exponential growth of information has made an overflow situation in the sea of information. It had created difficulties in the retrieval of relevant information. Efficient clustering methods are needed to improve the results of the retrieval. Document clustering is an automatic grouping of text documents into clusters so that documents within a cluster have similar concepts. In this paper, we applied Self-Organizing Map (SOM) algorithm to cluster Nepali text documents onto a two-dimensional map.

Vector space model is used to represent the Nepali documentsKeywords: Text clustering, Nepali documents, Self organization map.

1. Introduction

In the current scenario, browsing for exact information has become very tedious job as the number of electronic documents on the Internet has grown gargantuan and still is growing. It is necessary to classify the documents into categories so that retrieval of documents becomes easy and more efficient [1].Document clustering is a fundamental operation used in unsupervised document organization, automatic topic extraction, and information.

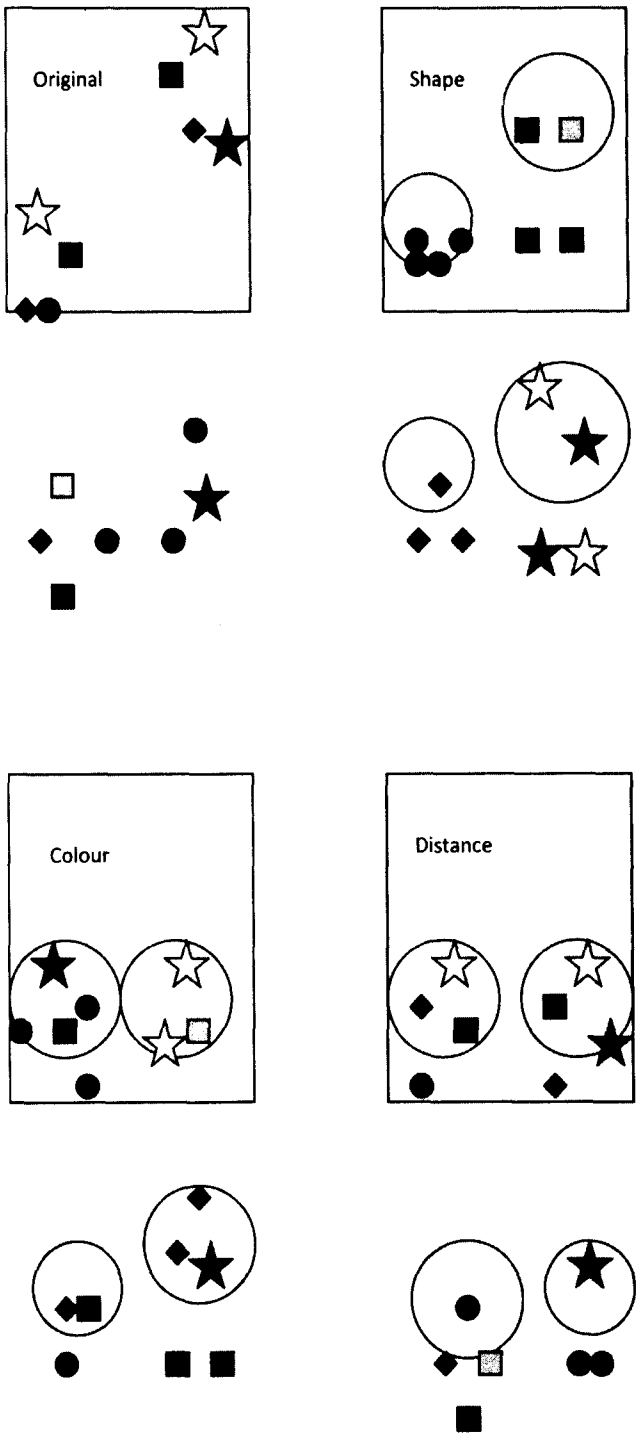
Formally, document clustering is an optimization problem where the input of the problem is a set of documents and a (dis)similarity measure between these documents. Thus, similarity plays

an important role in document clustering. Text document clustering provides an effective navigation mechanism to organize this large amount of data by grouping their documents into a small number of meaningful classes [2]. Document clustering can be defined as grouping of text documents into clusters so that documents within a cluster have similar concepts.

There are many kinds of clustering algorithms, suitable for different types of input data and diverse applications. A great deal depends on how similarity is defined between objects. Similarity can be measured in terms of objects' proximity (distance), or as a relation between the features they exhibit. An intuitive demonstration of this difference is shown in Figure 1 the same set of objects is grouped depending on their relative distance, or feature shape and color.

The vector space model is a widely used method for document representation in information retrieval. In this model, each document is represented by a feature vector. The unique terms occurring in the whole document collection are identified as the attributes (or features) of the feature vector. Different term weighting methods may be used in the vector space model, such as binary method, tf (term frequency) method, and tf-idf (inverse document) method [13].

The Self-Organizing Map (SOM) algorithm, which is developed by Kononen [5], is largely used in images and documents clustering. Kohonen's Self Organizing Map is an unsupervised learning technique. By using Kohonen's SOM, we can



reduce the dimensionality from a very high dimension into 2 or 3 dimensional space [1].The SOM algorithm works best with browsing tasks, especially in a very large document storage, such as a document warehouse [6]. The aim of this study is to apply SOM algorithm to cluster Nepali documents into a two-dimensional map. In this paper nepali documents are represented using vector space model and SOM is used to cluster the Nepali documents.

The rest of this paper is organized as following; Section 2 provides an overview of Nepali language, Section 3 provides a Description of the SOM algorithm, Section 4 describes the research steps. The evaluation and experiment results are discussed in Sections 5 and Section 6 concludes the paper.

2. Nepali as a language

Nepali is an Indo-Aryan language spoken by approximately 45 million people in Nepal, where it is the language of government and the medium of much education, and also in neighbouring countries (India, Bhutan and Myanmar). It serves as the lingua franca of an extremely multilingual part of the world: more than ninety languages are spoken within Nepal. Nepali is written in the Devanagari alphabet and has a written tradition extending back to the twelfth century [3]. The Ethnologue website counts more than 17 million speakers worldwide. In India there are about 5,00,000 Nepali speakers in Sikkim while in Darjeeling and Jalpaiguri districts of West Bengal there are about 1,400,000 speakers of Nepali. Nepali is a Head-right language i.e. in every phrase the head is on the right. The typical order of a VP is NP-VP. The typical order of a NP is ADJ-NP. The typical order of ADJP is ADV-ADJP. The typical order of PP is NP-PP i.e. the language is postpositional. It is written phonetically, that is, the sounds correspond almost exactly to the written letters. Nepali has many loanwords from Arabic and Persian languages, as well as some Hindi and English borrowings [4].

3. Self organising map algorithm

The SOM is an unsupervised competitive ANN, which transforms highly dimensional data into a two dimensional grid, while keeping the data topology by mapping similar data items to the same cell on the grid (or to neighbouring cells). A typical SOM is made of a vector of nodes for the Input, an array of nodes as the Output map, and a matrix of connections between each Output unit and all the Input units. Thus each vector of the Input dimension can be mapped to a specific unit on a two-dimensional map. In our case each vector represents a document, while the output unit represent the category that the document is assigned. The algorithm responsible to the map formation initializes the grid connections weight with small random values [7].

The Self-Organizing Map algorithm can be broken up into 6 steps [8].

1) Each node's weights are initialized.

2) A vector is chosen at random from the set of training data and presented to the network.

3) Every node in the network is examined to calculate which ones' weights are most like the input vector. The winning node is commonly known as the Best Matching Unit (BMU). (Equation 1).

4) The radius of the neighborhood of the BMU is calculated. This value starts large. Typically it is set to be the radius of the network, diminishing each time-step. (Equation 2a, 2b).

5) Any nodes found within the radius of the BMU, calculated in 4), are adjusted to make them more like the input vector (Equation 3a, 3b). The closer a node is to the BMU, the more its' weights are altered (Equation 3c).

6) Repeat 2) for N iterations.

The equations utilized by the algorithm are as follows:

Equation 1 Calculate the BMU.

$$DistFromInput\,2=\sum_{i=0}^{i=n}(Ii-Wi)2$$

I = current input vector
W = node's weight vector
n = number of weights

Equation 2a: Radius of the neighborhood.

$$\sigma\ t = \sigma 0\, e^{-t/\lambda}$$

t = current iteration
λ = time constant (Equation 2b)
σ0 = radius of the map

Equation 2b: Time constant

λ=numIterations /mapRadius

Equation 3a New weight of a node.

$$W\ t\ 1 = W(t)\ \Theta(t)L(t)(I(t)-W(t))$$

Equation 3b Learning rate.

$$L(t)=L0e(-t/\lambda)$$

Equation 3c Distance from BMU.

$$\Theta(t)=e(-distFromBMU\,2/(2\sigma 2(t)))$$

4. Methodology

Clustering of large collection of te t documents is a key process in providing a higher level of knowledge about the underlying inherent classification of the documents. It is necessary to classify the documents into categories so that retrieval of documents becomes easy and more efficient. Our research steps are as follows.

4.1. Acquiring documents.

We derived Nepali documents dataset from tdil website 11 . The written corpus in Nepali language provides data from different domains such as literature, science, media, art etc. The documents are in ML format, and needed to be transferred to plain te t.

4.2. Pre-processing documents.

We are dealing with the Nepali documents. Obviously these te ts will have sufficient number of Nepali punctuations, Nepali and English digits and Single-letter-words. These These are very common and have no additional meaning to the actual content of the te t, and has little or nothing to say about the te t itself. But while applying clustering algorithm to document dataset we need not take these unnecessary characters into consideration. So during this phase we remove these characters step by step. An e ample with the following input documents (each consisting of a single sentence) demonstrates this

Document	Content
D1	अर्थशास्त्र मुख्य गरी धनको अध्ययन हो।
D2	भारतमा लगभग २०% शिशुहरू यस रोगको सिकार हुन्छन्।
D3	अर्थशास्त्रको प्रकृति - अर्थशास्त्र विज्ञान वा कला दुवै हो ?

2.1 Tokenization : Tokenization is the process of breaking the sentences as well as the text file into word delimited by white space or tab or new line etc. Outcome of this tokenization phase is a set of word delimited by new line. For example

D1	D2	D3
अर्थशास्त्र	भारतमा	अर्थशास्त्रको
मुख्य	लगभग	प्रकृति
गरी	२०	-
धनको	x	अर्थशास्त्र
अध्ययन	शिशुहरू	विज्ञान
हो	यस	वा
।	रोगको	कला
	सिकार	दुवै
	हुन्छन्	?
	।	

4.2.2 Punctuation Removal As we are working on general Nepali text, there are lots of Nepali punctuations in the text. These characters have no importance. So we removed these punctuations.

D1	D2	D3
अर्थशास्त्र	भारतमा	अर्थशास्त्रको
मुख्य	लगभग	प्रकृति
गरी	२०	अर्थशास्त्र
धनको	शिशुहरू	विज्ञान
अध्ययन	यस	वा
हो	रोगको	कला
	सिकार	दुवै
	हुन्छन्	

4.2.3 Digit Removal

A general Nepali text file may contain Nepali as well as English digits. But as meaningful Nepali words do not contain digits, we remove these digits.

4.2.4 Single Letter-Word Removal

There exist a lot of words having a single letter. Most of these Single-Letter-Words are Stop-Words. Those words which have extremely high term frequency in a corpus are know as Stop Words. So the Single-Letter-Words are removed in this phase.

D1	D2	D3
अर्थशास्त्र	भारतमा	अर्थशास्त्रको
मुख्य	लगभग	प्रकृति
गरी	शिशुहरू	अर्थशास्त्र
धनको	यस	विज्ञान
अध्ययन	रोगको	वा
हो	सिकार	कला
	हुन्छन्	दुवै

4.2.5 Stemming

The next process after stop word removal is stemming. Stemmers try to identify the stem of a raw word in a text to reduce all such similar words to a common form, making the statistical data more useful. The process of stemming removes the commoner morphological and inflexional endings from words. Nepali stemmer [16] is

used to stem the words for each of the document in our stemming process.

4.3. Document Representation

A Document is represented by a set of keywords/ terms extracted from the document. Vector-space model introduced by Salton et al.[15] is the the widely used model to represent textual data. Vector Space Model uses the concepts of linear algebra to address the problem of representing and comparing textual data. In this model a document d is represented as a document vector [wt0 ,wt1 , . . .wtn], where t0, t1, . . . tn is a set of words of a given document and wti expresses the weight (importance) of term ti to document d. [12]

In the vector space model, the most widely-used weighting scheme is TF*IDF, which is the combination of the term frequency (TF), first used by Luhn in 1950s [9] and the inverse document frequency (IDF). TF*IDF of a term is expressed as a product of the probability that the term occurs in a document [10]. TF*IDF is mathematically rendered as

$Wij = tfi,j * \log (N / dfi)$

where Wij is the weight of the term i in document j,

tfi,j = number of occurrences of term i in document j.

N is the total number of documents in the corpus,

dfi = is the number of documents containing the term i.

For our example input, the term-document matrix looks as shown below.

	D1	D2	D3
अर्थशास्त्र	1	0	2
मुख्य	1	0	0
गरी	1	0	0
धन	1	0	0
अध्ययन	1	0	0
भारत	0	1	0
लगभग	0	1	0
शिशुह	0	1	0
प्रकृति	0	0	1
यस	0	1	0
रोग	0	1	0
कला	0	0	1
हुन्छन्	0	1	0
दुवै	0	0	1
सिकार	0	1	0
विज्ञान	0	0	1

4.4. Clustering documents with SOM

The Vectorized documents will be used as input data of SOM algorithm. In our work, we use the implementation of self organizing maps in MATLAB (Neural Network Toolbox). The size of the network (number of hidden neurons) is based on the desired number of clusters. The network then is trained on the input document vector for

about 300 epochs. After the training processes, the input data will be mapped to the Kohonen layer . For example the four circles in the figure below denote the four neurons (nodes) of the 2 x 2 SOM. The number inside the circle denotes the number of documents that were assigned to the neuron, after the self organization process. Each node in the figure below represents as a different cluster

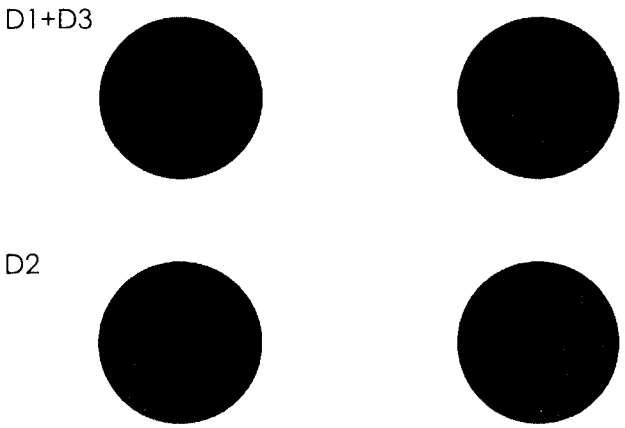


Figure 2: Figure of SOM where ,the number inside the circle denotes the number of documents assigned to that neuron.

5. Experimental result

The experiments were conducted on two Nepali text document datasets with the SOM algorithms. There are two main parameters to evaluate the performance of the algorithm, which are Accuracy and running time. Document preprocessing step is implemented in Java using NetBeans 7.3 and clustering algorithm (SOM neural network) is implemented in MATLAB (Version 7.9.0.324). All experiments were done on Processor P4 (3GHz) machine with 1GB main memory, running the Windows 7 Professional® operating system and all times are reported in seconds. The accuracy of clustering is given by [14]

$$\text{Accuracy} = \frac{\text{No. of documents correctly clustered}}{\text{Total No. of documents}}$$

The result obtained from the experiment is shown in the Table below.

	No. of documents	Total No. of Clusters	Running time	Accuracy
Dataset 1	47	8	2	.714285
Dataset 2	60	5	2	.785714

6. Conclusion

In this work, Nepali documents are represented using Vector Space Model after preprocessing the documents. Vectors of Nepali documents were created using the tf-idf method. We applied SOM algorithm to cluster Nepali documents onto a two-dimensional map. The method performed a completely automatic and unsupervised clustering of the Nepali documents. The experimental results are analyzed using running time and number of cluster produced. In the standard VSM for document representation, semantic relations between terms are not taken into account. In future, we hope to represent documents with semantics in the form of relations between the words in a sentence. With semantic information in document representation we expect to see an improvement in the performance of the document clustering system

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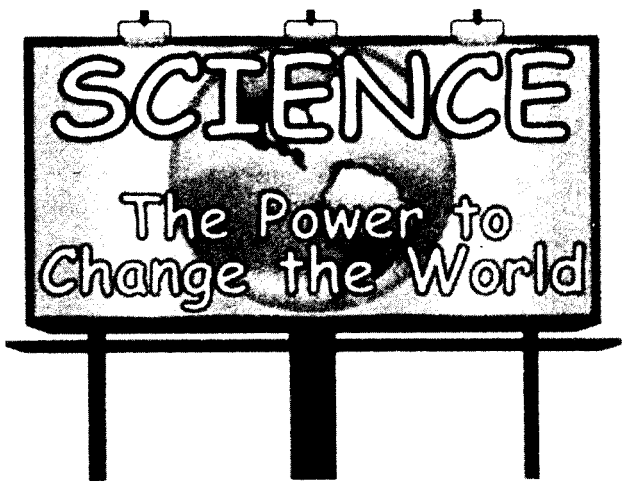

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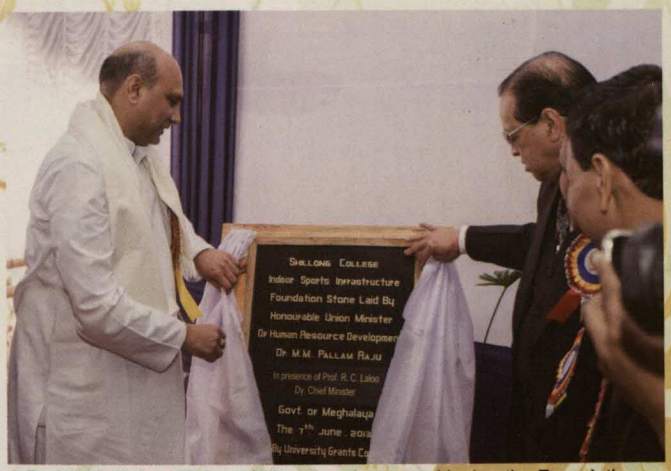

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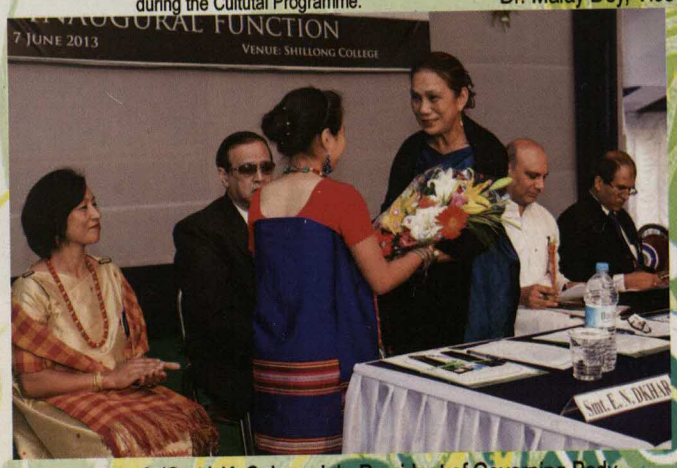

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