- Reduce taxation or exempt tax for companies including enterprises and manufacturers applying new technology, and exempt import tax for the acquisition of materials for the purpose of research and development (R&D) by research institutes;
- Draw up a National Strategy on Science and Technology up to the year 2020;
- Improve and develop IP infrastructure for facilitating R&D;
- Improve information and telecommunication infrastructure ensuring the capability of linking to the information network between institutes, universities and the industry in the country and abroad;
- Increase knowledge and continuing professional competence of S&T personnel of the public sector through providing training on creating innovation capability among researchers;
- Create more employment opportunities for researchers; and
- Strengthen linkages among the research institutes, universities and industries.

MYANMAR[20]

A. Profile

Myanmar is located in the Indo-Chinese Peninsula, with China to the North-East, Lao People's Democratic Republic to the East, Thailand to the South-East, Bangladesh to the West and India to the North-West. The Andaman Sea defines Myanmar's southern periphery and the Bay of Bengal is on its South-West. Myanmar has an area of 261,228 sq. miles and a population of over 54 million. The capital of the country is Naypyidaw. Myanmar's natural resources include teak, oil, natural gas, minerals, gems and marine resources. The major exports of the country are rice, teak, beans and pulses, rubber, coffee, minerals, gems and marine products.

B. Science and technology in Myanmar

With the aim of enhancing successful implementation of science and technology (S&T) development programmes, the State Law and Order Restoration Council established the Ministry of Science and Technology (MOST) on 2 October 1996. MOST is the premier agency mandated for S&T development in Myanmar. It has the following objectives:

- To carry out research and development (R&D) programmes;
- To strengthen the national economy;
- To enhance production in industrial and agricultural sectors;
- To produce and nurture human resources; and
- To conduct applied research.

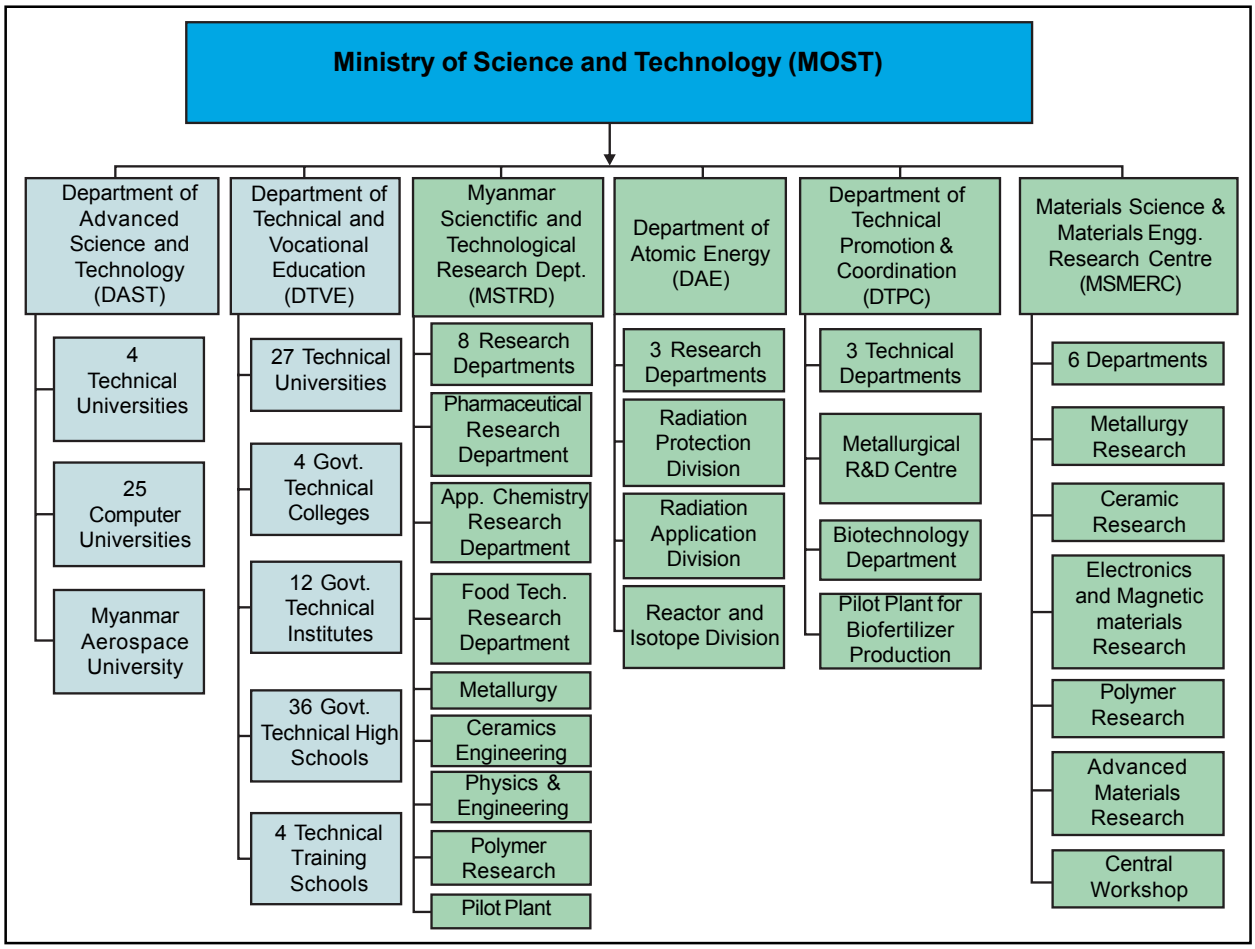
MOST has two basic functions: development of S&T human resources and S&T research and development (R&D). For S&T human resources development, MOST has two

[20] Presented by Dr. Kay Thi Lwin, Pro-Rector, Pyay Technological University, Ministry of Science and Technology, Pyay City, Bago West Division, Myanmar.

departments: the Department of Technical and Vocational Education (DTVE) established in 1954; and the Department of Advanced Science & Technology (DAST) started in 1997.

R&D is conducted through four old departments and two new ones. The pre-independence Myanmar Scientific and Technological Research Department (MSTRD) established in 1947 is the oldest among them. The Department of Atomic Energy (DAE) was formed in 1997, followed by the Department of Technology Promotion and Coordination (DTPC) established in 1998 and the Material Science and Material Engineering Research Centre (MSMERC) established in 2008. In 2010, the Technology Research Department (TRD) and the Biotechnology Research Department (BRD) were added. The organizational structure of MOST is given in Figure 19.

Figure 19: Organizational structure of the Ministry of Science & Technology, Myanmar



B. Human resources development

As the Union of Myanmar consists of different geographical regions where various national races reside together, it is important to have equitable development of all the states and divisions and to narrow down the differences between the rich and the poor

across the country. Therefore, the nation has been moving forward systematically in accordance with a combination of short and long-term plans on national economy and education, health and social sectors.

In 2002, the country started implementing a National Human Resources Development Plan that involved setting up 24 special development zones across the country. Each development zone has one government-run technological college, one government-run computer college, one arts and science university and one 200-bed hospital.

On 20 January 2007, MOST upgraded the government-run technical and computer colleges to universities and opened new technical high schools in all the special development zones. Currently, the country has 31 technical universities, 25 computer universities, 1 aerospace university, 4 government-run technical colleges, 12 government-run technical institutes, 36 government-run technical high schools and 4 technical training schools. The S&T human resources produced by all these educational institutions are given in Table 6.

Table 6: S&T human resources produced by educational institutions

Sl. No.	Degree	Degree holders
1	Ph.D. (Engineering/Computer/Biotech/ Applied Science)	1,219
2	Master of Engineering	3,480
3	Master Degree	1,011
4	Master of Computer Science	3,239
5	Postgraduate Diploma in Computer Science	5,253
6	Postgraduate Diplomas	1,374
7	Bachelor of Science/Technology	8,773
8	Bachelor of Engineering/Technology	66,466
9	Bachelor of Computer Science	21,685
10	Diploma in Engineering	92,661
11	Part-time Diploma	31,165
	Total	236,326

C. Research and development

R&D focus is on areas such as food science and technology; biotechnology, meteorology and geophysics; materials science and technology; information technology; non-conventional energy; marine science and technology; and space technology. Specifics are discussed below.

1. Food science and technology

Research on food science and technology aims to:

- Fulfil the need for trained workforce as well as for the management of establishments based on current and future national requirements;

- Excel in the field of education, training and research nationally and internationally; and
- Identify food technologies that will be key to national economic development in the longer term.

Research by the Department of Food Science and Technology of Yangon Technological University (YTU) under MOST is based on supporting national food security and food safety. It includes identification and characterization of food-related hazards, risk assessment of particular hazards in particular foods, characterization of physical and chemical properties of local resource both for processing and health purposes, post-harvest handling, and packaging and storage of local food resources to produce high-quality and safe foods. Basic research includes evaluation of unique characteristics of food components in terms of their physical, chemical and health functions.

2. Biotechnology

Ongoing research studies focus on genetics resource biotechnology, medical biotechnology, plant and agricultural biotechnology, biofertilizers, biogas, biopesticides, probiotics, malaria drugs, plant tissue culture, prawn/shrimp culture, and cattle breeding.

Future goals include: commercialization of biofertilizers, biogas, biopesticides and probiotics; production of plant hormones and enzymes; bioleaching of metal ores; wastewater treatment; crop seedling production; brood stock and strain selection for aquaculture; and development of transgenic crops. The stress is on processes that will benefit and serve the rural people in Myanmar.

3. Meteorology and geophysics

Myanmar is attempting to improve its agricultural sector by upgrading irrigation and water supply system. While several dams and irrigation facilities have been constructed, many more projects are at either construction or planning stage. Since meteorological and hydrological data are vital in planning of irrigation systems, several research works were conducted by YTU and Mandalay Technological University (MTU). Flood and drought study and watershed conservation and management study were among these.

The country is also upgrading the transportation sector by improving its national road network, both quantitatively and qualitatively. Problems related to damages of roads and other facilities owing to expansive soil are a major concern. Identification and classification of expansive soil and development of suitable methods against associated problems are still in a state that requires much improvement. Research of properties and deformation of expansive soils from some areas in Myanmar were conducted recently at YTU. Further research has to be carried out for other areas of the country.

Construction of high-rise buildings is becoming popular in major cities in Myanmar. It leads to the necessity of earthquake-resistant structures since seismic hazard in most regions of Myanmar ranges from moderate to high. Myanmar Engineering Society is attempting to establish a Seismic Design Code for Myanmar. All experts from related fields are cooperating in this task.

4. Materials science and technology

Under the supervision of MOST, there are 17 projects being implemented in four different areas of materials science and technology. All of them are ongoing projects covering magnetic materials, dielectric materials, structural materials, refractory materials, nano-materials, ferrous metallurgy, rare-earth metal extraction and foundry engineering. Working groups on nano-materials and nanotechnology have started work on nano-aluminium powder, carbon nanotube and ferrite materials.

5. Information technology

Information and communication technology (ICT) was introduced in Myanmar quite early with the establishment of University Computer Centre in 1971. The Computing Development Project financed by the United Nations Development Programme (UNDP) was implemented in 1993 for computerization of government organizations.

The Myanmar Computer Science Development Law was promulgated in 1996 and consequently Myanmar Computer Science Development Council (MCSDC) was formed. In 1998, representatives from three computer-related non-governmental organizations (NGOs) formed the Myanmar Computer Federation (MCF). The Federation and the NGOs did a very good job in improving the awareness of the power of ICT. When MOST was established, special emphasis was placed on ICT human resource development.

In November 2000, heads of Association of Southeast Asian Nations (ASEAN) countries signed the e-ASEAN Framework Agreement, under which an e-National Task Force was formed to coordinate the efforts for the implementation of the agreement. Six committees were formed to cover ICT infrastructure, legal infrastructure, education, application, standardization and liberation.

In 2001, MCSDC formulated the country's first ICT Master Plan, for the period 2001-2010. In 2002, a consortium of private companies established Myanmar Info-Tech, a special zone where adequate facilities and support are provided for ICT companies. In the same year, the Myanmar ICT Park was established and e-Government Projects initiated.

Myanmar has cooperated with external agencies in the field of ICT. In October 1998, Yangon in Myanmar was the venue for the 13th Asian Forum for Standardization of Information Technology and the 3rd International Symposium on Multilingual Information Technology. During 2002-2005, MOST sponsored three international ICT conferences.

6. Non-conventional energy

The energy from the national grid is quite limited and more than 90 per cent of village householders of the off-grid areas do not have electricity. Therefore, rural area development by applying non-conventional energy is a focal area of MOST.

YTU has designed and constructed a fixed dome type, 50 m^3 capacity biogas plant, which generates biogas from cow dung. Using a 15 kVA generator, biogas from the plant is able to provide electricity for two hours in the morning and four hours in the

evening to 300-400 households. During 2004-2005, 103 such biogas plants were established in three divisions. Myanmar Scienctific and Technological Research Department (MSTRD), YTU and MTU have successfully constructed and trialled a down-draft gasifier that uses wood chips and rice husk as input. Tests have shown that it is able to operate for 10 hours continuously, producing 30 kW of electricity.

Another research work targets production of synthetic diesel fuel from crude palm oil and waste cooking oil. The cyclic fluidized bed gasifier system that works using rice husk will be one of the areas for future research.

Wind power potential in Myanmar is relatively low and irregular, and the initial costs of harvesting wind energy are too high. Therefore wind energy research is limited in the country. The use of solar energy too is at the very initial stage, even though solar energy potential is around 51,974 TWh. The high initial cost associated with photovoltaics is the main reason for this.

7. Marine science & technology

The potential of fisheries in Myanmar is substantial because of the oceanographic conditions of its immense water body, such as the influence of delta rivers reaching far out into the sea and the absence of heavy industry along the coast. Two projects recently implemented to assess fishery resources are: application of remote sensing with environmental parameters for fishery forecast; and the integration of remote sensing and marine environmental parameters for identification of productive zones in the coastal waters. Future projects planned include coastal zone management and fishery application based on ocean colour and sea grasses by using remote sensing technology.

8. Space technology

The basic aims of Myanmar's space activities are: to explore outer space and utilize outer space for peaceful purposes; and to use the knowledge to meet the growing demands of economic construction, national security and S&T development. Remote sensing is one of the space technologies that Myanmar makes good use of.

The first introduction of Myanmar to satellite imagery was in 1980, under a Tropical Resources Assessment Project of the Food and Agriculture Organization (FAO) and the United Nations Environment Programme (UNEP).

The First Myanmar-India Friendship Centre for Remote Sensing and Data Processing was established on 15 February 2001, under a joint initiative of MOST and the Indian Space Research Organization (ISRO). Staff members of the centre have been trained on remote sensing technology applications using satellite images and TNTmips software. The Centre carries out research and feasibility studies in environmental resources development of Myanmar, such as agriculture, coastal and marine resources; urban land use; land cover; and forestry resources. The Centre is becoming a focal point for human resources development in remote sensing for MOST.

The Myanmar Aerospace Engineering University (MAEU) and YTU provide advanced education in aerospace technologies.

Myanmar has also engaged in international-level collaborations with member countries of ASEAN, India, China, Republic of Korea, Japan, Pakistan and some European Union countries in terms of: exchange of scientists and researchers; exchange of S&T news and documents; and conducting conferences, workshops and training programmes on S&T topics.

Besides bilateral engagements with some countries in the Asian region, Myanmar is also a member of several regional groups as well as international organizations such as International Electrotechnical Commission (IEC), International Organization for Standardization (ISO) and World Intellectual Property Organization (WIPO). It is in a number of sub-committees of the ASEAN Committee on Science and Technology (ASEAN COST).

D. Conclusion

As can be seen from the above, Myanmar does not have a well-structured National Innovation System as yet. However, the country has many of the required components, such as a basic S&T framework, human resources, natural resources, etc. What it lacks are the linkages, policies and integration of components. Hopefully, this workshop would give some direction towards this.

NEPAL[21]

A. Background

Nepal is a landlocked, mostly mountainous country situated between China in the North and India in the South, East and West. Its terrain that covers an area of 147,181 sq. km is 35 per cent mountainous and 42 per cent hilly, with only 23 per cent plains. The country, with Kathmandu as its capital, has a population of 28 million. This federal democratic republic has an annual growth rate of 2.2 per cent. Administratively, Nepal is divided into five development regions, which are further divided into 14 zones and 75 districts.

B. Status of science and technology

In Nepal, five governmental bodies formulate science and technology (S&T) policies, as required:

- Ministry of Science and Technology;
- Different sectoral ministries;
- National Planning Commission;
- Environment Protection Council;

[21] Presented by Mr. Sanu Kaji Desar, Under Secretary, Ministry of Science and Technology, Nepal.