

*M. Kamal Uddin*

## **REVERSE ENGINEERING : A PROMISE FOR HARNESSING SUSTAINABLE TECHNOLOGICAL DEVELOPMENT IN BANGLADESH**

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### **Abstract**

Reverse Engineering is a process of diffusion of technologies that plays an important role for incremental change leading to sustained technological development. Reverse engineering can be considered as an essential phase for a developing country like Bangladesh for triggering technological revolution and can act as forward and backward linkage in the process. This paper hinges upon the conceptual setting, momentousness of Reverse Engineering for the country's industrial growth and the present status of Reverse Engineering practices in the country. Pragmatic solutions and required organizational set up are proposed in the paper against various hindrances and problems prevailing in the country in the process of following Reverse Engineering technique. Observations made in the paper are based on a sample survey undertaken on light engineering industries and three national workshops on 'Reverse Engineering' organized recently.

### **1. Introduction**

In a developing country like Bangladesh, due to lack of technological capability, financial resources, market and appropriate institutions, there is limited opportunity to develop totally new technology to meet the specific needs of various sectors of the country. On the other hand, there is good opportunity to adapt imported technology through Reverse

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Engineering. Reverse Engineering is a process of learning to replicate a technology by observing and analyzing an existing technology, then making modification to it, thus facilitating the process of dynamic transfer of technologies. At first, it is aimed to develop capabilities to replicate a specific technology, then to use the experience in modifying and developing new technologies through innovative process to suit local conditions and needs.

In all production activities, it is a recognized process to acquire experience through Reverse Engineering. From the history of developed countries, it can be found that Reverse Engineering had played momentous role at the initial stage of technological development. Examples of many countries can be cited around the world that had technological and financial limitations in the past like our country, but they have geared themselves step by step to the top stage of technological development and thereby of economic prosperity. South Korea, Thailand, Malaysia, Taiwan are vivid examples of such development. In those countries, technological development was basically founded on Reverse Engineering. They entered into the world market by replicating the potential technology of western countries. Japan has reached to the top stage in the world by using the acquired knowledge from Reverse Engineering and adjoining their own innovative capabilities to it. South Korea, Taiwan, Hongkong, Thailand, Malaysia and many other countries are continuously getting developed technologically step by step by adopting Reverse Engineering.

The importance and benefit of Reverse Engineering can hardly be ignored for a developing country like Bangladesh, as it is one of the recognized measures for promoting technology dissemination through technology transfer and adaptation. It can

create indigenous technological base and initiative towards building domestic technological capability. It will impart efforts towards development, adaptation and assimilation of modern technology and industrial growth in the country. Supporting Reverse Engineering activities in the Small Engineering Enterprises (SEE) will substantially contribute to income and employment generation with overall impact on GDP of the country. Reverse Engineering can be cost-effective for adopting and adapting available technologies to meet the local needs in Bangladesh. One important consideration is that the technology coming from more rapidly developing Asian countries is likely to be more suitable and adaptable to Bangladesh needs, where operating conditions are equally demanding. In addition, labour in Bangladesh is not in scarce and with low remuneration which give extra-added advantage on the job training and execution.

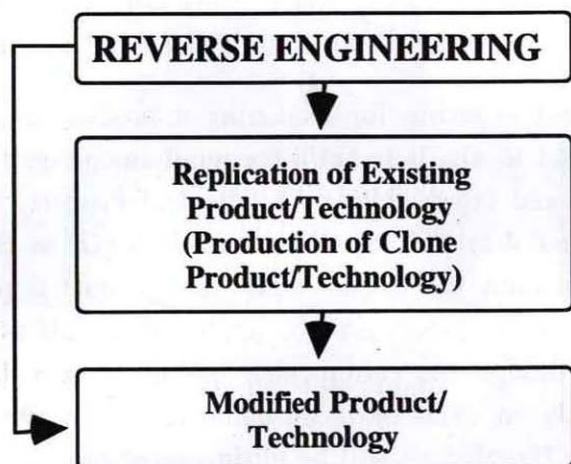
A sample survey was conducted on Light Engineering Industries (LEI) in Dhaka and other districts of Bangladesh. The prime objectives of the survey at the first stage were to find out about the status of Reverse Engineering practices in the country and the products that are presently being made through Reverse Engineering. In the second stage, onus was to identify the problems that are impediment to the growth of the Light Engineering Industries associated with Reverse Engineering practices in the country and to find out the solutions of the problems. Later, three national workshops on 'Reverse Engineering' were organized (each continued for one week) in 1998 & 1999 to probe about various aspects of Reverse Engineering practice in the country. Participants from small industries (owner, manager, foreman, technician) from all over Bangladesh attended the workshops. This paper addresses some of the findings of the survey and the workshops.

## 2. Concept of Reverse Engineering

The main objective of Reverse Engineering is to acquire the capability to replicate an existing technology and make further modification and development on it. In this technique, the design, drawing and specification for production are prepared by disassembling each part of the existing product/ technology. The design, shop drawing and other information required for production can be procured by purchasing production right (license) of the technology from the innovator/originator. Due to various reasons/problems, in most cases, it becomes difficult for the entrepreneurs to procure the required design data, drawing etc., pertaining to production. In those cases, the entrepreneur takes step to produce the technology through Reverse Engineering. In this technique, the producer/entrepreneur prepares the design data and decides about the materials, fabrication or manufacturing/production process in the light of his experience & technological capability and by examining carefully the various parts of the product/technology. Due to replication, the defects/difficulties of existing technology may encompass into the new product/technology. But an entrepreneur/producer through his innovative capability may exterminate those problems/defects. When a product/ technology is sub-divided into smaller unit, opportunities evolve to add improvement to the unit. Thus in Reverse Engineering, opportunities always exist to adjoin a stream of improvements in the new technology. Clone technology is an identically produced technology of the existing one. Finding defects/difficulties in the clone technology, an entrepreneur sometimes switch over directly to the second step (Fig. 1). In that case, the entrepreneur modifies the design data prior to the production.

### **3. Patent System and Other Procedural Requirements while Making Products through Reverse Engineering**

In Reverse Engineering, it is essential to have knowledge about patent law, trademark rules, ordinance & laws of WIPO (World Intellectual Property Organization), WTO (World Trade Organization) and other procedural requirements. Before merchandizing a product, firstly, it is required to acquire patent of the product. Patent, Design and Trademark Directorate, Government of Bangladesh is responsible for issuing patent and trademark of an industrial product. The office sanctions patent for scientific and technological innovation, and design registration for design innovation as per Patent & Design law 1911 and Patent and Design rules 1933. Patent is a recognition certificate preserving proprietary right legally of a technological innovation issued to the innovator on application. Trademark is a distinguishing mark or device warranting goods for sale or commercialization. Intellectual property can be divided into two categories: i) Industrial properties (require patent, trademark, etc.) and ii) works related to literature, arts, movie, etc. (require copyright). Bangladesh Patent Office deals with patent of two major aspects of industrial property, namely, i) design innovation and ii) functional innovation of the product. Patent can be sanctioned of a product made through Reverse Engineering with either design and/or functional modification/innovation. The extent of modification/innovation of a product required to fulfil minimum requirement for sanctioning patent is contingent on various factors such as momentousness of the innovative part on overall performance, interactive and gross functional capability of various parts, extent of novelty produced on the product due to augmentation of innovation, etc., among others. Sanctioning patent of a technology, a patentee acquires a monopoly proprietary right for



**Fig. 1. Two Basic Steps of Reverse Engineering**

a certain assigned period (normally 16 years with maximum 10 years extension for special case) to use, produce commercially, sale or provide license to others to use the technology. Thus from this monopoly right, a patentee or his licensee does not face any competition in the market. In modern patent law, there are provisions to patent both the product and production process. There are specific rules and regulations for patent and licensing in national and international context. Production and marketing of a technology by a person other than patentee or his licensee during the lifetime of a patent is infringement of the law. But if the patent life of the technology is expired or if it is not patented, then producing the product/technology through Reverse Engineering and marketing it, is not unlawful. After expiry of the patent life, any person can use, produce and merchandize the product/technology without obtaining any permission of the previous patentee or originator. Bangladesh Patent Office works for within the territorial base of the country and is responsible for issuing patent for commercialization within the country only. To

get a patent of the same product in any other country, application to be made separately to the patent office of that country.

The next criterion for marketing a product in national and international levels, is to fulfil the requirements pertaining to the ordinance and laws of World Intellectual Property Organization (WIPO) and World Trade Organization (WTO) as Bangladesh is member of both WIPO and WTO. If a product is patented with WIPO, then the patent will be applicable to all of its member countries though the entrepreneur has not patented the product individually in each of those countries. Thus marketing of a product in Bangladesh will be infringement of law if the product is already patented with WIPO by another party, and does not matter whether the product, in Bangladesh, has not been previously patented or has been patented at later stage by Bangladesh Patent Office. Details of WIPO patented products and their patent-expiry dates can be available from WIPO office, Geneva. As a result of discussions for many years, the developed countries formed the WTO in 1995. WTO is a world's trade rule making body and Bangladesh is a signatory. The trend of the time is for globalization and the WTO is the torch bearer of the process. WTO has specific laws pertaining to international proprietary rights. The relevant laws, rules, and requirements, of WIPO and WTO are available with Ministry of Commerce, Government of Bangladesh. The WTO laws are going to be strictly enforced after the year 2004 in the changed context of market economy around the world. Bangladesh has to organize its system, laws and promote capability in order to prepare for the year 2005 and so on. The examples of gaining technological advancement through Reverse Engineering by the East Asian countries particularly Japan, South Korea, Taiwan, Thailand and Malaysia

render us a fastest way and methodology to reach such goal. Their experiences are quite relevant to Bangladesh particularly in the post-cold war era. Governments of these countries have provided framework of legislative backing and adopted other numerous measures and public policies for implementation of Reverse Engineering practice. Some of these have been focused in Section 4. Bangladesh can develop the Reverse Engineering practice keeping an eye to all notices pertaining to laws and ordinances of international proprietary right systems. Reverse Engineering is not mere a replication of the existing technology or to acquire the capability to replicate an existing technology but also is entangled with further modification and development on it. Selection of potential patent-expired or unpatented products/technology of developed countries or applying various modifications to an existing product/technology can be a policy in Reverse Engineering practice in Bangladesh.

#### **4. Focus on Public Policies for Implementing Reverse Engineering Practices in East Asian Countries**

Reverse Engineering practice has a key role in recent success of 'Asian Tigers' in technological development. The success in Thailand, South Korea, Japan, Taiwan and Malaysia has clearly demonstrated that a well planned approach towards acquisition and dissemination of technology through Reverse Engineering by a dynamic learning and absorption process can raise productivity and bring revolution at an accelerated rate. Some of the relevant public policies pertaining to processes of technology assessment, forecasting and diffusion were the root to make path for technological development in these Asian countries. Some of these policies adopted in these countries in national level are focused below:



**(1) Explicit Recognition and Commitment to Technology Development in National Level**

- (a) Recognition of the role of technology and Reverse Engineering for technological development
- (b) Integration of technological considerations in national planning
- (c) Two major styles of technological development are envisaged
  - (i) The development of total technology (by adopting predominantly the second and third Phases of Reverse Engineering).
  - (ii) The transfer of western technology (mainly by Reverse Engineering): In Thailand, in the past, the private sector had to decide the type of technology to be replicated and each entrepreneur had to invest alone. Later, after 1972, the government of Thailand decided to take over responsibility for technology transfer to boom industrial development.
- (d) Explicit commitment to technology as a strategic variable
  - (i) Legal commitment : South Korea was among the first, and still remains among the few developing countries, that provided legislative backing for development of local technology by adopting and adapting existing technology.
  - (ii) Strategic Aspects : The technological development strategy pursued by South Korea in the process of industrialization can be stated quite simply: bold introduction of appropriate advanced technology from the developed countries for assimilation and improvement while simultaneously promoting the development of domestic capacity for indigenous technological development.

- (e) Role of mass media for promoting and popularizing a technology culture
- (f) Commitment to technology as a strategic variable

## **(2) Development of Technical Manpower**

- (a) Policies related to human resources development
- (b) Policies related to technical education and training
- (c) Policies related to structure of technical manpower
  - (i) Policies for career system for scientific and technical personnel
  - (ii) Mobility of qualified technical personnel
- (d) Policies related to technical and managerial skill development

## **(3) Legal, Financial and Fiscal Measures**

- (a) Policy Instruments and Institutions

*(i) Legal measures for promotion of technology development in private industry* : A number of legal measures have been enacted in South Korea in order to support and stimulate industrial technology development. Examples includes the Law for the Promotion of Technology Development, the Engineering Services Promotion Law, the Assistance Law for Designated Research Organizations and others.

*(ii) Support for establishing research institutes in private industries* : According to the Law of South Korea, the government can make suggestions for improvement for research and technical facilities when they are found deficient, to firms that are in the category of strategic industries. If the government intervenes in

such cases, it provides various kinds of support necessary for improvement, for example, exemption of up to 10 percent of investment made. In addition, firms are allowed to depreciate the total investment made on research and test facilities at the rate or 50 percent for the first year. They are entitled to long-term, low interest loans for the purchase of capital items.

*(iii) Support for commercialization of new/reverse product/technology:* When an enterprise decides to commercialize a new reverse product/technology in South Korea, the enterprise is given a tax exemption of 8 to 10 percent on the capital investment or on corporate tax. Also the enterprise is entitled to long-term, low interest financing from government designated banks. When an enterprise in South Korea attempts to develop a new technology indigenously, the enterprise is given a tax exemption of 8 to 10 percent on capital investment or on corporate tax. Also the entrepreneur is entitled to long-term, low-interest loan from government.

*(iv) Protection of manufacturing firms producing new reverse product/technology.*

*(v) Notification of technologies domestically developed*

*(vi) Proprietary rights*

*(vii) Industrial technology research association*

In South Korea, the Industrial Technology Research Association is an incorporated body of enterprises that got together for the purpose of jointly seeking solutions to technological problems common to them. The government encourages the industry establishing the Association by providing financial as well as administrative assistance.

(b) Activities leading to creation of an innovative culture

(i) Legal measures to ensure continuity to technology policies

(c) Support for Technology Adoption

(i) Policies for acquisition of foreign technologies: Accelerated introduction of foreign technology:

In China, during the period of Sixth-Five Year Plan, rapid progress had been achieved in the adoption of new/foreign technology by Reverse Engineering (9.2 billion dollars). The long-term plans and annual plans of state technology adoption are drawn up by the department of the State Council or the people's governments of the provinces, autonomous regions and municipalities. During eighties, China was studying the system of technology acquisition and undertook many measures to encourage scientific research institutions to adapt technology to strengthen the digestion, absorption and use of foreign/new technology. Some policies and legislation for promoting technology modernization were remarkable.

The South Korean government had initiated the process of accelerating the introduction of foreign/new technology into both private and public sectors. To this end, the laws and regulations governing the inflow of foreign technology and engineering services into South Korea have been increasingly liberalized. While developing countries often resort to more stringent regulatory measures, South Korea has been unique in designing laws and regulations that promote introduction of foreign technology.

(ii) Policies and incentives for adoption of new/foreign technology:

The government of Thailand deems it essential for selected foreign/new technologies to be adapted, to be in accord with the local production system. Government agencies concerned with technology adoptions such as the Technology Transfer Center, consider adaptation of foreign/new technologies, one of their major policies. But for the private sector, such opportunities are less due to commercial interests and levels of capability in technology. For the public sector, the adaptation of new/foreign technologies is seen mostly in the agricultural sector and in small-scale industries in rural areas such as cottage industries.

(iii) Inadequacy in digestion and improvement of newly adopted technology

(iv) Phased liberalization of technology adoption

(d) Support for indigenous technology

(i) Policies and incentives for promoting demand for indigenous technology development

(ii) Policies for protecting national intellectual and industrial property

(iii) Stimulation of domestic R & D activities

(iv) Risk capital and financial intermediaries for commercialization of indigenously developed technology :

In Thailand, each year, the cabinet approves a big amount which the private sector can borrow for the development of indigenous technology for commercial purposes. The fund, which is under the management of the Ministry of Science, Technology, and Energy, aims at the development of science and technology of Thailand. Repayment of a loan is in the form of subsidy.

(v) Protection and promotion of indigenous technologies through tariff and other adjustments.

(vi) Promotion of exports by national enterprises using indigenous technologies.

#### **(4) Technology Support Facilities**

- (a) Information and document services
- (b) Computing services and software packages
- (c) Standardization and quality control

(i) Instrumentation, testing and calibration facilities

- (d) Engineering and management consultancy services

(i) Improvement of technical capability of domestic engineering services

#### **(5) Technological Capability**

- (a) Promoting status of research institutions
- (b) Promoting status of technology generation
- (c) Promoting status of technology generation and transfer

(i) Promotion of private research institutes

(ii) Support for small and medium industries

(iii) Policy for technology transfer

- (d) Commercialization and diffusion

#### **(6) Sources of Light Engineering Industrial Growth**

- (a) Accumulation of capital and responses to trade opportunities
- (b) Changes in non-economic factors
- (c) Technology assessment

## **5. Unplanned and Unorganized Practice of Reverse Engineering in Bangladesh**

Practice on Reverse Engineering can be found in scattered and unorganized way in Bangladesh. The example of Dholai Khal is known to everybody. In Bangladesh, there are hundreds of roadside workshops scattered all over the country. Some of them are equipped with as little as only an electric welding machine, while others are equipped with equipment like milling machine, lathes, drilling machines, grinders, welding sets, etc. These workshops are involved with various types of works like fabrication of simple machine parts like bolts and nuts and complex machines like lathe machines, concrete mixing machines, etc. Besides these, there are small/medium workshops involved with the manufacturing of household items such as building grill, taps, bib cocks, etc., made of different kind of materials. These small workshops make substantial contribution to the Gross Domestic Product (GDP) and employment generation. These small engineering industries all over the country are involved with Reverse Engineering activities but do not follow appropriate technological procedural requirements of Reverse Engineering. On the basis of limited knowledge, these workshops are capable of producing 'look-alike technology' but not the same technology as the original one. General complain from the consumers is that the products they produce do not give the same performance as the original one, although they may look similar. In simple term, all the workshops are not capable of making quality and standard products. In certain cases, even if they can make a prototypes of quality product, they cannot produce them in mass quantity. That means scale of production is very limited owing to many reasons and problems prevailing in the country. It is utmost important for

a product to ensure and maintain its quality and standard when produced through Reverse Engineering. In order to disseminate technology in the country and to ensure survival in the competitive market in the context of globalization and market economy, superiority to be achieved by developing indigenous technological expertise and capability.

From the sample survey and workshops, it was revealed that Light Engineering Industries (LEI) around country are engaged in production of many types of multi-disciplinary products using Reverse Engineering. From those, a short list of some of the products and their producers are presented below (Table 1 & 2).

**Table 1. A short list of some of the products made using Reverse Engineering technique by LEI around the country**

Sl. No.	Products ( <i>made using Reverse Engineering technique</i> )	Producer (Light Engineering Industries) (The numeral mentioned against a product is the serial number of the Light Engineering Industry listed in Table 2)
01.	General Machinery Parts (Ordinary Components) ● Nut-Bolt ● Shaft	1,5,6,10
02.	Workshop Machines ● Lathe Machine ● Surface Grinding Machine ● Nut Cutting Machine	1,46 7 46
03.	Water Heater, Autoclave, Boiler ● Water Heater ● Autoclave	16 12
04.	Different Type of Engines and its Components: (Petrol/Diesel/Marine Engine) ● Piston ● Cylinder ● Ring	1,7,8,13,15,28,35,40,42,44 1,7,8,11,13,15,35,40 1,7,13,15,42



Sl. No.	Products ( <i>made using Reverse Engineering technique</i> )	Producer (Light Engineering Industries)
		(The numeral mentioned against a product is the serial number of the Light Engineering Industry listed in Table 2)
04.	<ul style="list-style-type: none"> <li>● Liner</li> <li>● Crank Shaft</li> <li>● Bush</li> <li>● Oil Pump</li> <li>● Hydraulic Pump</li> <li>● Gear Pinion</li> <li>● Gazon Pin</li> <li>● Gazon Bush</li> <li>● Governor's Bush</li> <li>● Kin Pin</li> <li>● Diesel Engine Machinery Parts</li> </ul>	1,7,8,11,13,15,26,27,28,35,41,44 1,7,11,13,15,35,40 1,5,7,11,13,15 13 13,15 6,7,13,18,24 1,5,6,7,11,13,15,26,27,28,35,42 1,5,6,7,11,13,15 1,5,6,7,13 6,7,13,15 20,21,22
05.	Agricultural Production Machinery and Parts (Agricultural Implements) <ul style="list-style-type: none"> <li>● Power Tiller</li> <li>● Power Pump</li> <li>● Spraying Machine</li> <li>● Power Spraying Machine</li> <li>● Dhenki' Pump</li> <li>● 'Spense Pipple', Tee</li> <li>● Deep Tubewell Machinery</li> <li>● Dredging Pump</li> <li>● Self Priming Pump</li> <li>● Impeller</li> </ul>	1,5,6,7,20,21,22,25,29 1,5,6,7,25,39 1,6,7,41 1 1 19 21 39 39 30
06.	Agro-Processing Machinery and Parts <ul style="list-style-type: none"> <li>● Paddy Thrasher</li> <li>● Corn Thrasher</li> <li>● Oil Expeller Machine</li> <li>● Double Gear Oil Expeller Machine</li> <li>● Sugarcane Crushing Machine</li> <li>● Rice Huller</li> <li>● Rice Mill Machine</li> <li>● Wheat Crushing Machine</li> <li>● Flour Mill Machine</li> <li>● 'Suji' Mill Machine</li> <li>● 'Shamai' Mill Machine</li> </ul>	5,6,7 4,6,7 1,4,5 4 4 4,5,23,35 4,16 4 2,4,34,35 23,35 4
07.	Food Industries Related Machines <ul style="list-style-type: none"> <li>07.1 Bread &amp; Biscuits Factory Machines               <ul style="list-style-type: none"> <li>● Vertical Mixing Machine</li> <li>● Sugar Grinding Machine</li> </ul> </li> </ul>	4 4

Sl. No.	Products ( <i>made using Reverse Engineering technique</i> )	Producer (Light Engineering Industries)
		(The numeral mentioned against a product is the serial number of the Light Engineering Industry listed in Table 2)
08.	Machinery for Ice Plant/Cold Storage/ Refrigerator/Air Conditioner/Air Cooler etc. and its Components	
	● Air Conditioning Machine	38
	● Refrigeration Machine	38
09.	Jute & Textile Industries Machinery and its Components	
	● Power Loom	5
	● Hydro Machine	10,12
	● Ballooning Squeezer Machine	10
	● Netting Tube Dryer Machine	10,35,36
	● Yan Dyeing Machine	10,12,36
	● Stretching Machine	10,36
	● Rubber Grinding Machine	15,20
	● Colour Mixer Machine	10,36,37
	● Giger Machine	10,36
	● Washing Machine	10,12
	● Dryer Machine	10,12
	● Calender Machine	10,35
	● Tread Machine	10
	● Jute Mills Spare Parts	18,24,45
	● Textile Mills Machinery	21,24,34,45,48
	● Weaving Machinery Parts	32
	● Hydro Extractor	36,37
	● Tumbler Dryer (Gas)	36
10.	Construction Related Machines and Spare Parts	
	● Pugmill, Soil Mixer Machine	4,9
	● Piling Winch Machine	2,7,9
	● Dreck	2,9
	● Concrete Mixer Machine	4,7,20,29,33
	● Tower Bolts, Hinges, Pad Lock, Washer	30
11.	Transport Machines	
	● Tampoo' Vehicle	5
	● Van	15
	● Shallow Engine Van	7
12.	Electric Bulb Making Machine	12

Sl. No.	Products (made using Reverse Engineering technique)	Producer (Light Engineering Industries)
		(The numeral mentioned against a product is the serial number of the Light Engineering Industry listed in Table 2)
13.	Household Goods	
	13.1 Electric Household Goods	
	● Ceiling Fan	16
	● Exhaust Fan	16
	● Emersion Heater	16
14.	Electric Components	
	● Electrical Light Fittings	17
	● Ballast	47
	● Super Enamel Copper Ware	47
15.	Crushing Machine (Crusher)	
	● Bone Crushing Machine	21
16.	Blending Machine	
	● Detergent Blender	4
17.	Packaging Machines	
	● Jute Bailing Hydraulic Power Press	4
18.	Sealing Machine	
	● Plastic Packet Ceiling Machine	12
19.	Bottling Machine	12
20.	Plastic Molding Machine	
	● Plastic Mold	14
21.	Saw Mills Spare Parts	20
22.	Vertical Litget Youth Hoist	21
23.	Cutting Machine	
	● Horn Cutting Machine	21
	● Horn Table Machine	21
24.	Welding Machine	22,43
25.	Battery Charger	22
26.	Inverter	22
27.	Aluminum Furniture	31
28.	Sluice Gate	33
29.	Printing Machine	41

**Table 2. A short list of some of the Light Engineering Industries that make products using Reverse Engineering technique**

*(Their corresponding products are appended in Table 1)*

Sl. No.	Light Engineering Industries	Sl. No.	Light Engineering Industries
1.	Khan Engineering Works R.N. Road, Jessore	12.	Raju Engineering Works 42, Tipu Sultan Road, Dhaka-1100.
2.	Zia and Brothers Dhaka Trank Road, Pahartali, Chittagong	13.	Didar Engineering (Pvt.) Ltd. 74, Rishikesh Das Road, Narinda, Dhaka
3.	Ali Hossain Engineering Works Rangpur Road, P.O. Saidpur, Nilphamari	14.	Bipa Engineering Works 16/1, Tipu Sultan Road, Dhaka-1100.
4.	R.R. Engineering Works Station Road, College Gate, Dist. Natore-6400	15.	Nipun Engineering 29/1, Goalghat (New Road), Dhaka
5.	Azmiri Engineering Works Old Bus Tarminal, Jamalpur.	16.	Raj Metalex 121 West Monipur, Mirpur, Dhaka.
6.	Murad Karigori Karkhana, Gaibandha.	17.	Pacific Electric Industries Plot No. 2, Rd. 22, Kadamtali Area, Dhaka.
7.	Meton Machinery And Engineering Works, Gohail Road, Bogra.	18.	Sunlight Moulding & Engineering Works 154, East Nasirabad, Baizid Road, Chittagong.
8.	Nadi Engineering Works Railway Market, Bogra-5800	19.	Iqbal Engineering Works Cantonment Road, Sayedpur, Dist. Nilphamari.
9.	Alo Engineering Works Fatulla, Narayangonj.	20.	Amin Engineering New Babu Para, Saidpur, Dist. Nilphamari.
10.	Ali Engineering Works Railgate, P.O. Monnoonagar, Tongi, azipur	21.	Masoom Engineering Works Cinema Road, Saidpur, Dist. - Nilphamari.
11.	Binimoy Engineering Works 10/1, Dhalaikhal New Road, Dhaka.	22.	Beco Engineering Works Rangpur Road, Sayedpur, Dist. - Nilphamari

Sl. No.	Light Engineering Industries	Sl. No.	Light Engineering Industries
23.	Bondhu Engineering Works Station Road (Lamba Gass), Dist. - Jamalpur	36.	Laskar Engineering & Electric Targass, Gazipur.
24.	Dae-Kun Engineering Works Kawria Para, Norsingdi.	37.	The Chistia Engineers Station Road (Thana Gate), Tongi, Gazipur.
25.	Kakoli Engineering Works Gurpokur Mor, Kajal Sharani, Satkhira.	38.	Technical Workshop Mechanical Engineering Dept., BIT, Gazipur
26.	Reza Engineers & Metal BSCIC Industrial Area, Bogra.	39.	K.S.D. Engineering Works 21/1, Modanpal Lane, Nababpur, Dhaka.
27.	Arif Engineering Works Gohail Road, Suttrapur, Bogra.	40.	Nurani Engineering Works 52, Tipu Sultan Road, Dhaka- 1100.
28.	Akota Engineering Workshop Gohail Road, Suttrapur, Bogra.	41.	Jewel Engineering Works 15/8-9, Tipu Sultan Road, Dhaka-1100.
29.	Thangamara Mohila Sobug Shangh (T.M.S.S). Thangamara, Gokul, Bogra.	42.	Abul Gaskit Centre & Engineering Works 74/1, Lalmohan Street, Dholaikhal, Dhaka.
30.	Brother's Hooks Industries B-149, BSCIC Indust. Est., Supura, Rajshahi.	43.	Akbar Engineering Works 7, Taherbagh Lane, Thatari Bazar, Dhaka
31.	Zitu Enterprise A-178, BSCIC Esate, Supura, Rajshahi.	44.	Gaushia Engineering Works 20, Tipu Sultan Road, Dhaka- 1100.
32.	Khaja Engineering Works B-218, BSCIC Ind. Est, Supura, Rajshahi.	45.	Rubel Engineering Works 15/19, Tipu Sultan Road, Dhaka-1100
33.	Technitians Steel Works Santahar Road, Naugaon	46.	Sunrise Engineering 31, Nondalal Lane, Luxmi Bazar, Dhaka
34.	Azmiri Iron & Engineering Works 138, B.B. Road, Narayanganj	47.	Diamond Electrical Industries Plot No. 55, Rd. 21, Shampuri C/A, Dhaka.
35.	A-1 Engineering Works 31, R. K. Mitra Road, Narayanganj	48.	Faruque Engineering Works 74/1, Laboratory Road, Dhaka- 1205.

## 6. Basic Phases of Reverse Engineering: Conceptual Setting

It is essential to understand the basic concepts, principal phases, sub-phases, and technical aspects of Reverse Engineering. These are shown schematically in Fig. 2 to 5.

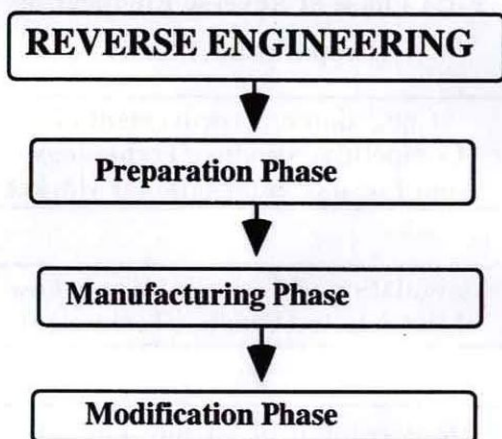


Fig. 2. Three Phases of Reverse Engineering

## 7. Management in Reverse Engineering Industries

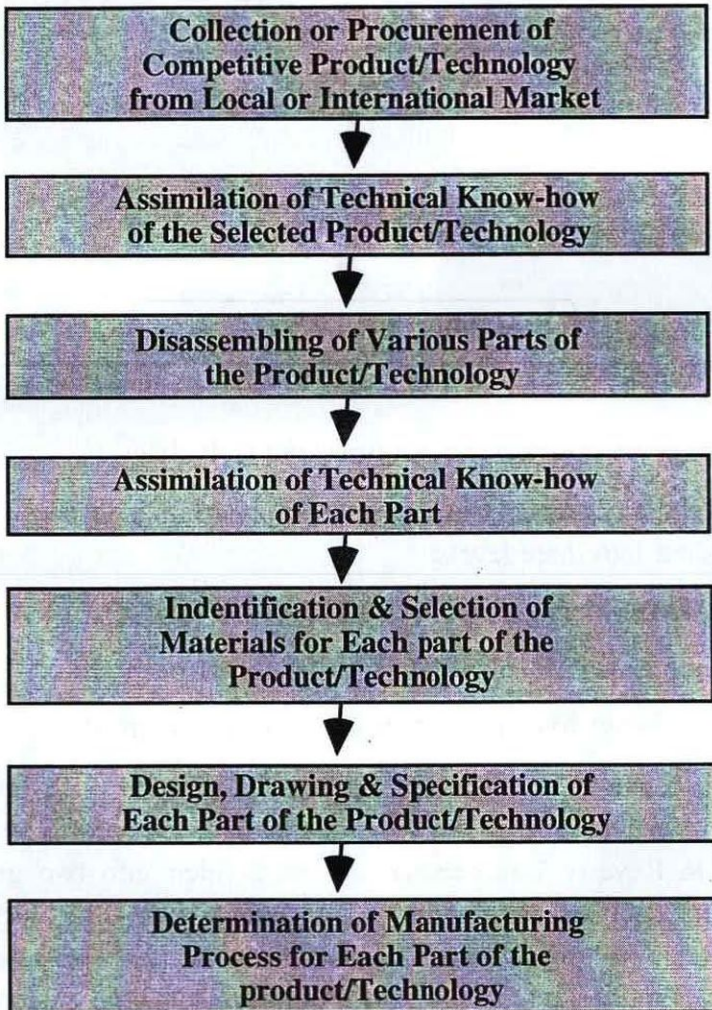
Overall management in Reverse Engineering Industries can be configured into three levels:

- Top Level Management (overall responsibility),
- Middle Level Management (specific responsibility) and
- Lower Level Management (production management).

It is essential to take appropriate decision in each level of management. In most cases, decisions that are required to be taken under in Reverse Engineering can be divided into two groups: long run decisions and short run decisions. Long run decisions are related to product selection and its design, decisions on Reverse Engineering process and required machinery, selection of level of technological knowledge and arrangement of finance,

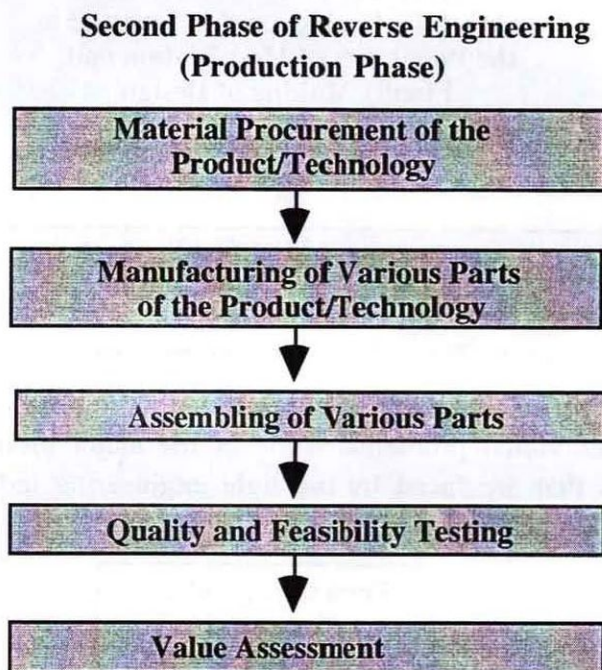
developing expertise in design work and production process, etc. On the other hand, short run decisions are related to production planning, selection and proper use of raw materials, production

### **First Phase of Reverse Engineering (Preparation Phase)**



**Fig. 3. First Phase of Reverse Engineering**

control, improvement of the quality of product, improvement of productivity of machinery, assessment of market demand and strategy of marketing, etc.



**Fig. 4. Second Phase of Reverse Engineering**

Research and development (R & D) of a product is an integral part of product management and marketing. Since the choice and need of people change rapidly, continuous R&D is important to modify the product to satisfy the consumer needs. The interaction of basic functions of management is shown in Fig. 6.

## **8. Problems and Hindrances in Adopting Reverse Engineering in Bangladesh**

In the sample survey and workshops, problems in the Light Engineering Industries & Reverse Engineering were investigated



### Third Phase of Reverse Engineering (Modification Phase)

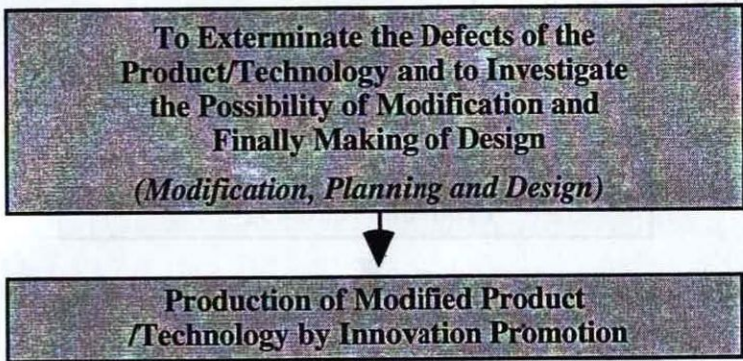


Fig. 5. Third Phase of Reverse Engineering

and tried to find out their solutions. In the context of various types of individual problems, some of the major problems and hindrances that are faced by the light engineering industries in general in Bangladesh were identified. These are listed below:

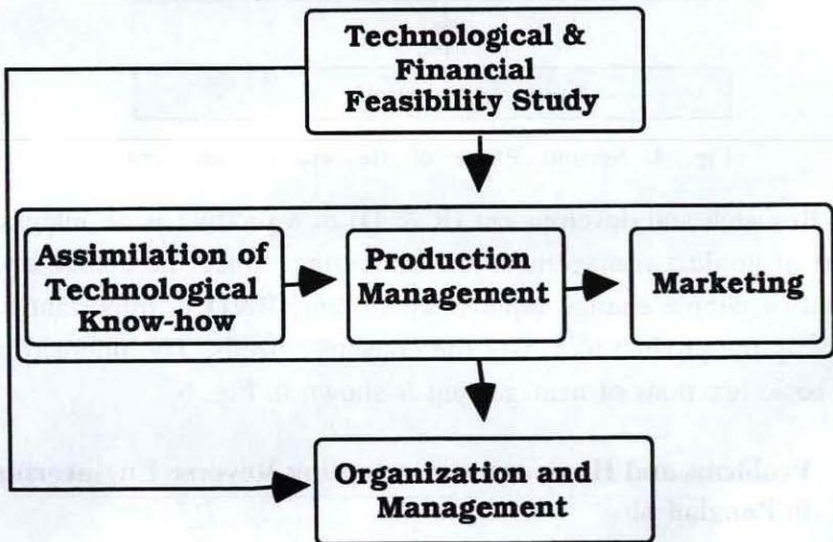


Fig. 6. Interaction Among Various Elements of Management in Reverse Engineering

## 8.1 Problems of Reverse Engineering Practice in Light Engineering Industries in Bangladesh

### (a) Problems Related to Raw Materials

- (i) High price of raw materials
- (ii) Sometimes required raw materials become scarce in the market; also required quantity sometimes become dearth. Very often it is seen that some basic raw materials required for certain products cost very high. Thus the concerned industry suffers in purchasing these with high price.
- (iii) In some cases, high quality raw materials are required for certain special type of production. Usually, these high quality raw materials are not available in the local market as per required quality or quantity.

### (b) Problems Related to Finance

- (i) Lengthy and cumbersome procedure to receive loan from government/bank.
- (ii) In many cases, it is difficult to achieve required amount of government/bank loan.
- (iii) Non-availability of sufficient working capital.
- (iv) Low tariff rate for imported goods that competes with the local ones.
- (v) Risk capital and financial intermediaries / non-availability of venture capital : It is difficult to obtain financial back up for research of a new/uncertain technological innovation and development.
- (vi) High interest rate on bank loan.

**(c) Problems Related to Technological Development and Management**

- (i) Non-availability of metal testing facility: The artisan faces difficulties to identify various metals, constituents and their quality.
- (ii) Foreign machine with greater efficiency and its spare parts: Sometimes not available or incurs high cost.
- (iii) Sometimes, efficient and skilled manpower related to the job is not available.
- (iv) Sometimes, proper working space is not available in the workshop or required extension of the workshop can not be done.
- (vi) Government contracts: Most of the time it become difficult/impossible to obtain a government contract/project.
- (vii) Load shedding problem: Production hampers due to interrupted electricity supply.
- (viii) Non-availability of heat treatment, tempering and other facilities required for metal or light engineering industries. Durability of the product becomes low due to lack of tempering/treatment facilities.
- (ix) Lack of policies, technological back up, skilled manpower required for product diversification.
- (xi) Sometimes it is not possible to make a better quality product due to limited purchasing capacity of the local market.
- (xii) Lack of product design and manufacturing capability.
- (xiii) Production manual in Bangla is needed for general artisan/craftsman which is normally not available in the market.

- (xiv) Efficiency of workers declines due to low remuneration.
- (xv) Absence of R&D (Research and Development) facilities.
- (xvi) Lack of standard and quality of product (ISO 9000, ISO 14000).
- (xvii) Lack of knowledge pertaining to patent system and other procedural requirements.

(d) Problems Related to Marketing

- (i) Sometimes, the price of local good is high in comparison with the foreign goods due to high cost of local production. Thus local goods can not compete with the foreign goods.
- (ii) Lack of facility or capability of the owner to disseminate information/ advertise about the workshop and its products.
- (iii) Demand of the local products is less than the foreign products: Government patronization with respect to price reduction, quality improvement and augmenting market demand of the products is very much needed.
- (iv) Non-availability of policies for price fixation of a product: This results fluctuation of the price very much and the industry faces problem to cope with the trend.

Among above constraints, the following can be identified as major and deep rooted problem that are being faced by the small engineering enterprises.

- (1) Lack of required investment/fund,
- (2) Lack of material testing facilities,
- (3) Absence of proper information system,

- (4) Lack of technological knowledge and capability,
- (5) Lack of training facilities,
- (6) Lack of modern machinery and production facilities,
- (7) Non-availability of proper raw materials with appropriate quality and required quantity,
- (8) Problems relating to marketing of the products

Besides above, many other tangible and intangible problems are involved.

### **9. Some Proposals as Pragmatic Solutions of the Existing Problems Hindering Diffusion of Reverse Engineering in Bangladesh**

Some proposals of the pragmatic solutions of each of the problems and hindrances stated earlier came out from the sample survey and the workshops. These are listed below:

- (1) Arrangement of loan facility for capital/investment fund/venture capital from government/bank/financial organizations/Non-government Organizations (NGO).
- (2) Establishment of metal/material testing facilities at various industrial areas of the country.
- (3) Establishment of proper information network system throughout the country.
- (4) Arrangement of formal technical education by holding training programmes for the technicians, manager, foreman, owner-manager, etc., of small industries at regular interval of time throughout the year.
- (5) Establishment of modern machinery and production system required for the reverse products.

- (6) Formulation of appropriate strategy for marketing of the reverse products.
- (7) Arrangement of required supply of proper raw materials with respect to quality and quantity.

Proposed organizational setup and strategies for solving the existing problems and for dissemination of Reverse Engineering practice in Bangladesh are shown in Fig. 7.

### **10. Policies to be Adopted for Dissemination of Reverse Engineering Practices around The Country**

Appropriate policies/strategies in the government/private levels will help quick acquisition and dissemination of technology through Reverse Engineering. Some of the strategies are mentioned below:

#### ***(1) Training Programme for the Technicians***

Reverse Engineering is a production oriented research programme. To implement this programme successfully, capability of the technicians to be developed continuously. In order to promote Reverse Engineering practice and to bring dynamism and growth in the industrial sector of the country, training programmes to be organized at regular interval basis throughout the year. Training is available on some specific trades in vocational institutes, technical training centers, etc, which are insufficient compared to the country's need. Most of the technicians of light industries do not have opportunity to get institutional training. They learn from observation and by doing work. For those working-technicians class, it is very much essential to arrange training programme to promote their overall trade skill.

***(2) Training Programme for the Owner/Manager***

In order to enhance the managerial capability and efficiency of owner/manager of industries, training workshop on industrial engineering management, technology management, marketing strategy, etc., to be arranged at various industrial areas of the country at regular interval of time.

***(3) Arrangement of Capital/Investment Fund/Venture Capital***

For investment capital, assistance from government/bank/financial organization should be available. Bangladesh Small and Cottage Industries Corporation (BSCIC) has a policy to provide loans to the entrepreneurs. Government should formulate policies to provide loans to small industries at low interest rate. R&D activities play important role for innovation promotion in light engineering industries that require venture capital for such activities. In order to do research work and make preliminary model or pilot project through Reverse Engineering, government should take initiative to provide venture capital to the light engineering industries.

***(4) Patent Law, Trade Mark Rules, WIPO and WTO Laws***

Prior to merchandize a product, entrepreneur should be aware about patent law, trademark rules, international proprietary right system, WIPO and WTO obligations. For a newly innovative product, it is advantageous and essential to acquire patent from local and international body (such as WIPO).

***(5) Standardization and Quality Control of the Reverse Product***

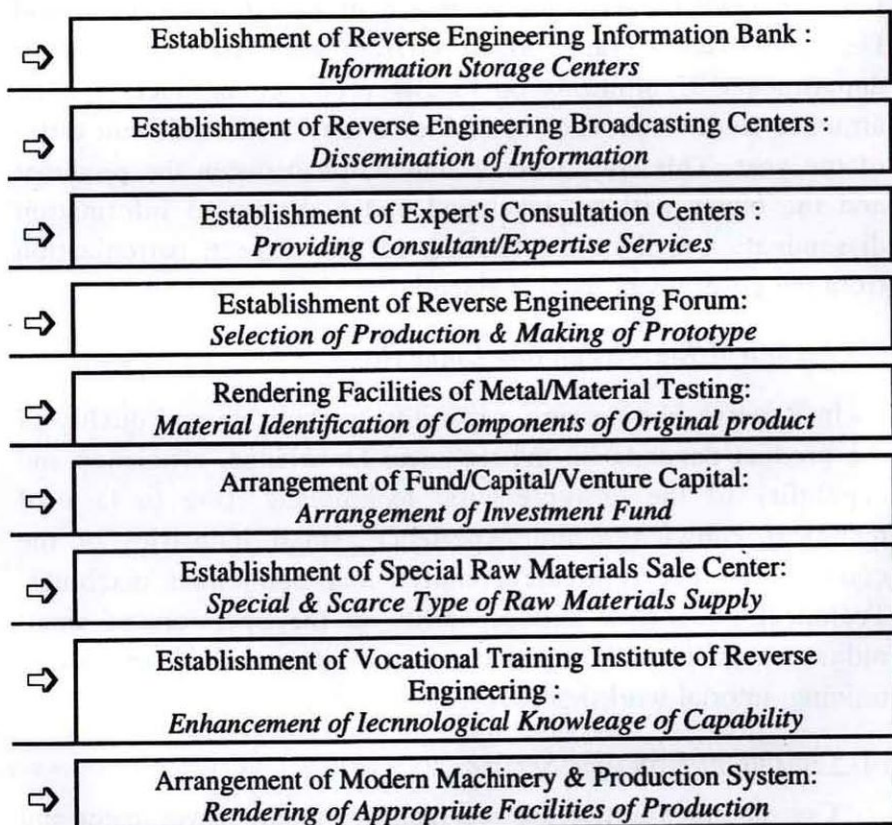
Quality must be ensured while making the reverse products. As per BSTI (Bangladesh Standards and Testing Institute) ordinance,

it is compulsory for a company to procure license for producing and marketing any of the 130 BSTI enlisted items. It will be extra efficacious if the product secure ISO 9000 certificate for quality and ISO 14000 for environmentally friendliness.

**(6) Information Network System throughout the Country**

In Bangladesh, the critical hindrance in the way of industrial growth and technological development is the absence of proper

***Proposed Organizational Setup and Strategies for Dissemination of Reverse Engineering Practices in Bangladesh***



**Fig. 7: Proposed Various Organizational Setup**



information system. Information on products/technologies in terms of materials, production facilities, organization, etc., are very much essential especially for the entrepreneurs. The information from the government departments is not easily available to the general people. An efficient, independent, reliable, dependable and easily accessible information system is essential for industrial growth and technological development. This can be done with the help of various organizations such as Federation of Chamber of Commerce and Industries, Bangladesh Small and Cottage Industries Corporation (BSCIC), BITAC, Bangladesh Steel and Engineering Corporation, Small Industries Owner's Association, Bangladesh Industry Owner's Association, Board of Investment, Patent and Design Office, Trade Mark Office, etc. and government departments. Exhibitions on locally produced products can be arranged in different regions of the country at the different times of the year. This way a better interaction between the producer and the buyer will be developed and a system of information dissemination will be established. In this respect, patronization from the government level is essential.

#### (7) Technical Knowledge and Capability

In Reverse Engineering, capability to replicate and quality of the product depends on the technical knowledge, efficiency and capability of the entrepreneurs/ technicians. Due to lack of technical knowledge and experience, small industries of the country can not replicate complex and compound machines. Technical know-how and capability of the operators of small industries to be developed by formal institutional education, training, tutorial workshop, etc.

#### (8) Consultant/Expertise Service

Consultant/expertise service facilities in the government and private sectors to be developed for replication of technology.

Presently, there is no institutional base in the country to render overall technical assistance (technology selection, design and production). In this context, the Owner's Associations of Engineering Industries can develop 'Consultancy Service Center' on their own initiative at various industrial areas of the country. Some public organizations such as Bangladesh Small and Cottage Industries Corporation (BSCIC) can take initiative to arrange consultancy service.

(9) Modern Machinery and Production System

In the modern age, the production-machinery are continuously being upgraded and the newly innovated machinery is replacing the old ones. Thus in order to compete in the market economy system, machinery to be upgraded time to time. There must be facilities available in the country where the entrepreneurs can be assisted with the modern machines. Presently, BITAC produces good quality machine parts and renders assistance to the industries. Owners/associations of the industries/factories can develop facilities of upgraded machinery and production system.

(10) Material Testing Facilities

Presently, industries are suffering due to lack of sufficient metal / material testing facilities in the country. Government or privately owned organization can be established to provide such facilities at different industrial areas of the country.

(11) Marketing of the Reverse Product

Success in marketing of a reverse product is contingent on the product quality, service, price, promotion, place and many other factors. So before selection of a product, these aspects are to be considered. Marketing of a new product may fail if the target

group is too small, actual cost of product is much higher than the expected costs, quality of the product is very low, or marketing efficiency is poor.

## 11. Conclusions

Reverse Engineering can translate technology into productive reality and is able to bring technological revolution in a country like Bangladesh. There is tremendous prospect of Reverse Engineering in the country especially in the light engineering industrial sectors. The local technological capability and indigenous knowledge can contribute significantly to the process of adaptive improvements. In Bangladesh, Reverse Engineering practices do not follow the systematic procedural requirements. The products or technologies made through Reverse Engineering do not possess quality up to the required standard. Under this circumstance, it is essential to improve the quality of the products by developing proper techniques and following appropriate procedures of Reverse Engineering. Entrepreneurs should be cognizant about the obligations pertaining to patent law and trademark rules, ordinance and laws of WIPO and WTO while producing a product/technology through Reverse Engineering. For a new product, first onus is to get patent from Bangladesh Patent Office. The product can be patented internationally by obtaining patent from a single organization (WIPO). Merchandizing a patented product by one other than a patentee or his licensee is transgression of laws. But it is not infringement of laws to market a product/technology if it is patent-expired or not patented previously. In this context, Bangladesh can adopt a strategy to select potential patent-expired or unpatented products/technology of developed countries or applying various modification to an existing product/technology to merchandize them by producing through Reverse Engineering.

The small engineering industries in our country have got many limitations that hinder production of quality products. Technological development can not be ensured unless these limitations are identified and overcome. In this paper, a number of problems have been identified and their solutions have been discussed. Policies / strategies in the government / private levels to set up organizational base will render enormous potential in dissemination of Reverse Engineering. To disseminate Reverse Engineering practice in order to bring dynamism in the industries, it is essential to have good training facilities, proper method of acquisition of technology, arrangement of required investment, proper information system, material testing facilities, modern machinery, advanced production system, standardization & quality control of the product, expertise service facilities and appropriate policy.

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