Reverse Engineering and Technology Transfer

Gholamreza Amini

Faculty member to Payam Nour University, Iran

Abstract In recent years, issues of market development and exports have become the biggest concern for senior executives of engineering and manufacturing organizations. The question is, how to reduce the gap from the developed countries in shortest possible time and have a good share in the world trade? Study in nations which did not achieve technology over time, and tried to adopt it in some point of time shows that, in the first step, the extensive use of reverse engineering techniques for basic understanding of product and then making and upgrading them according to the needs, itself is an appropriate way. Promoting and supervising the proper execution of a systematic process of reverse engineering and the application of tools and engineering techniques in this process, can also have a significant impact on the achievement of Technical Knowledge of products at minimal cost and shortest amount of time (which have not been achieved due to lack of systematic approach).

In this article, methodology of this system is summarized, while expressing various technology strategies, statues of research and development in achieving the m and then selection of reverse engineering strategy as a convenient way of progress for developing countries.

Keywords — Technology, Strategy, Development, Reverse Engineering.

I. INTRODUCTION

Undoubtedly knowing the product and understanding the factors affecting its characteristics, is the first prerequisite to improve the quality and innovation which requires engineering understanding of fundamentals of functional pieces. Reverse engineering is used to recover and identify the components of a product especially in the absence of access to the basic design and is also used to maintain, expand and develop the existing facilities and re-engineering. This is considered as an acceptable method for developing countries. In this process, first, the lack of technical information is determined to support the production of a product. Then with a cohesive teamwork, consisting of experts and researchers in different disciplines of basic sciences along with suitable managing and organizing of research and development (R & D) establishment, tries to achieve documents and product design plans. the stages of prototyping and pilot and, if necessary, production of the product is carried out by considering the specifications, purpose and conditions of product design, national and common standards and also covering the unknowns and unexplored points. Research and development activities in a general sense, have always had two products: One is knowledge and information and other one is technology. The role of research and development activities in building technology is to the extent that, scholars have claimed, the technology is a product of Research & Development factories. Technology is key factor development and also the most powerful factor for economic development in communities. According to Atlas Technology, Technology is a complex combination of four elements of:

1. Hardware and Machinery;
2. Technical knowledge or informational tools;
3. Capabilities, including human skills and initiatives;
4. Organizing and managing technology including mechanisms that are needed to facilitate the effective integration of all the above elements.

As the importance of technology in national development and the role of Research & Development in achieving technology were reminded, now stages of technology life will be expressed. The life cycle of any technology includes the following stages:

- Design stage;
- The introduction stage;
- Development stage;
- Maturity and perfection stage;
- Decline stage.

II. STRATEGIES TO ACHIEVE TECHNOLOGY AND PRODUCTS

Basically, there are different ways to achieve technology as an industrial product, that every country applies them in every industrial field, based on its scientific and industrial structure and the level of self-reliance in the field of science and technology, the availability of necessary financial resources, domestic raw materials, type and quality of specialized personnel, international and regional political relations. The major types of strategies to achieve new product and desired technology are as follows:
1. INNOVATION AND DESIGN STRATEGY UP TO PRODUCT MANUFACTURING, THROUGH RESEARCH-PRODUCTION PROCESSES;

2. TECHNOLOGY DEVELOPMENT STRATEGY;

3. SIMULATION AND REVERSE ENGINEERING STRATEGY;

4. STRATEGY OF SELECTION, TRANSITION AND LOCALIZATION OF TECHNOLOGY;

5. STRATEGY OF EFFECTIVE USE OF FACILITIES AND TECHNOLOGY;

6. STRATEGY OF ESTABLISHING THE FACTORY AND PRODUCTION PROCESS FOR COMPLETE DELIVERY;

7. STRATEGY OF BUYING DESIRED GOODS AND TECHNOLOGY.

Necessity of technology behaviour recognition to select the right strategy:

One of the strategic decision making in the field of access to a product or technology, is to select the most appropriate way to achieve it, that this decision depends critically on its growth stage and development of the product or technology (In the country of the formation and the emergence and evolution of technology). For example, if a technology in its creating country (origin country) is in introduction stage, then any actions to achieve it through technology transfer are ill-considered. Also, if the product is in the stage of fall and decline in its origin and is being replaced by superior technology, then any action to achieve the product through this strategy is a risky business. Basically, it is more reasonable for developing countries to technology transfer products which have passed introduction stage at the place of origin and are in the growth stage. In this case a developing country action to achieve the same product or technology, through research to production strategy, would be something uneconomic and unwise, unless considered for goals such as strengthening the country's scientific and technological base, which probably will not be a desirable strategy. The more the degree of development of a technology before decline and obsolescence stage, the more cost-effective procurement strategy of products and technology.

The targeted strategy in this article, according to the technological needs of developing countries such as Iran and compensation of this technological gap with advanced countries in the fastest way possible is reverse engineering strategy, and its methodology will be discussed in the followings.

III. REVERSE ENGINEERING METHODOLOGY

Reverse engineering is one of the methods that companies use to speeds up their product development process. This method in developing countries such as Iran, which are behind advanced countries in terms of product design and manufacturing technology, is an answer to increase design ability and accelerate development process. Creating a logical and systematic method for determining the amount of shortage of technical information to support the production of a product, and then carrying a cohesive teamwork to complete this information, are all the series of activities undertaken in reverse engineering process. Level of required technical information, that will all attempts tries to identify its deficiency and then resolving the information deficiency, is called Technical Data Package (TECHNICAL DATA PACKAGE = TDP).

Despite the need of elegance and high degree of precision in reverse engineering, shortening the process is very important in this context. Here is a brief description of the overall process of reverse engineering and its methodology as follows:

❖ First stage - Analysis of the efficiency / economy:

This activity consists of 2 parts:

A - Scoping and collecting information: At this stage, product development, debugging and self-sufficiency of the product is introduced and then the objective of project about each one is explained. The purpose of this gather information phase is to collect all evidences in order to make production data and technical documentation easy during the implementation of reverse engineering.

Technical data package can be gained by methods such as identifying similar cases, collecting information on producers and examining parts and assemblies lines of a higher level product that highlights the present information on input and output factors, adjacent parts and final consumption, specifications and description to buy parts, parts list and schematics which provide basic information to configure a piece or a set. Naturally, by classification of level of data on engineering processes, this work becomes more comprehensive and more systematic and avoids potential duplication and helps the cost savings.

B - Evaluation of data and Planning: The purpose of this phase is to identify the level of incomplete required information and also estimating the cost of reverse engineering. Based on this estimated level, preliminary estimates will be done on expertise, testing, equipment, etc. to implement the reverse engineering and then, after cost estimation, resource allocation and accurate time estimation to produce this data to complete package of technical data,
Gantt Chart of project implementation will be presented and a plan is achieved for the work.

- **Second stage - performance analysis and case disassembly:**

Each case can be made up of several components (mechanisms and components) which are responsible for each specific task and their outcome creates the desired task. And at this stage of the process, reverse engineering team should be able to identify parameters and important characteristics of input and output of each component. After identifying the components and its inputs and outputs (Using engineering judgment, experimental designs, computer simulations, etc.), performance of components must be audited with available technical documentation to determine conflicts (FUNCTIONAL CONFIGURATION AUDIT = FCA phase = audit of components technical performance). In continuation, required technical information of components are extracted through testing, PCA phase or Physical Configuration Audit, separation and assembly of components, in case if components are degradable to smaller parts, can continue to reach to part level, until a level is stated for assembly. In separation stage, the functional task of smaller parts should be recognized to audit the technical performance of parts and physical configuration audit on them. At the end of this stage, the technical data packages which have been created and completed during the audit operations of technical performance and physical configuration audit, after validation, will provide information about the mapping of a level (state of mechanisms movement and performance transfer to other components are fully specified).

- **Third stage - Analysis of hardware and software:**

These activities which are the most important part of reverse engineering include the following:

A. Analysis of materials: It is conducted by chemical and metallurgical analysis, study of superficial layers, measuring mechanical properties, the structural and defects studies;

B. Study of the manufacturing process: It is carried out according to type of physical levels in a segment, possible process for production of these levels, study of surface tension and microstructures and measuring some non-critical features such as surface smoothness that indirectly help in identifying the manufacturing process;

C. Dimensional analysis: Which comprises upon the steps of measuring dimensions, tolerances analysis and sensitivity analysis;

D. Electronic Analysis - if necessary: Based on the output characteristics of the circuit, materials, methods of coating removal, required fittings for reproduction. The results obtained from this part is recorded and drawn in the maps of Level 2.

- **Fourth stage - product improvement and value analysis:**

Using the provided new information while performing a systematic review and value engineering process in considered candidates for reverse engineering, can reveal and correct some costly areas before completing the process, such as design flaws, additional design, performance improvement, excessive restrictions on tolerances, excessive requirements for performance and etc.

- **Fifth stage - planning the production process and providing quality assurance requirements:**

At this stage, all packets that have already been completed, in terms of production capabilities and manufacturing processes are taken under consideration. In short, the output of this stage leads to create a map of the level 3, which includes essential requirements and the requirements of design, engineering, manufacturing, quality control to acquire or to build the targeted items. Generally, Level 3 maps are the result of the reverse engineering process that includes all the documented parameters required for manufacturing an item and the purpose of doing it, is verification of the accuracy of the technical data package to support the production of parts, so that adequate assurance of the accuracy and completeness of maps and created characteristics by reverse engineering process is achieved.

- **Sixth stage - Preparation of final documentation:**

During manufacturing and testing of products in the production phase, many engineering drawings and test procedures are revised several times, that all reviewed levels from zero level to the latest results should be placed in the technical data package. By adding the information obtained from the inspections and quality assurance of the produced samples, to the technical data package, a complete package of technical data can be obtained and then after matching with the standards of technical data packages, a final full package of technical data related to the product is achieved at the end, which is the ultimate purpose of the reverse engineering process.
IV. ADVANTAGES AND ACHIEVEMENTS OF REVERSE ENGINEERING:

1. Technical strengthening and ability of manufacturing technology through complete product understanding and examining (obtaining technical knowledge of products) and to create confidence in the engineers and industry experts in the face of domestic industries and technologies;

2. Ability to design an updated product at the global standards with discovering new ways to improve the product, in order to satisfy customer needs, such as better performance, additional features and to fix product defects. Also satisfy the needs of the market such as technological changes or product improvement and cost reduction;

3. Creating attracting potential, in transfer of advanced technologies;

4. Training required manpower in strategic industries;

5. The creation of systematic steps to help to understand and design documentation and the design process;

6. Possibility of competitive benchmarking and modelling, in order to understand the competitors' products and better development of our products;

7. The possibility of re-engineering using the technical knowledge obtained by reverse engineering.

V. CONCLUSION

Reverse engineering is a method of access to technical knowledge. The existence of product sample is highly required for this method which is the base of further research work. In this method, projection of technical information through the decomposition of the product is used for acquiring technical knowledge which is so-called explores of technical knowledge or Defacate. In this process, experts consider specifications, objective and product design requirements and try to manufacture product according to national and common standards and also to cover the unknowns and unexplored problems by tact and expert surveying and researches, without being involved in the technical details and product design from the beginning. Perhaps reverse engineering could be named as a deliberate copying of a product, a method which was actually implemented by some East Asian and European countries after the Second World War and currently, they are part of advanced and industrialized countries. However, useful experiences in recent decades, with scheme of technical and technological support to industries by providing cheap capital and government support through appropriate taxation policy and ... on subjects and various products in the country, all confirms productivity and this fruit bearing strategy, in response to the needs of the country. Interesting point is that internal experts gain confidence and technical courage with such experiences to deal with foreign experts in the process of technology transfer and obviously can provide, the condition of complete attraction of technology transfer, understanding of technical and scientific blind spots in domestic industry and attempt in resolving it, directing of technology transfer, consultancies with the authorities in line with decision making, production contracts and partnerships with foreign companies, etc. Reverse engineering is used in the hardware and software in various fields, including: to overcome the drawbacks or expanding capabilities of the existing devices, supplying spare parts and establishment of repair centres and maintenance of advanced systems as a tool for learning, a tool for creating new and compatible products that are cheaper than the currently available products on the market, a tool for competition, to improve software performance, and is important in the field of computer hardware and software.

VI. REFERENCES

[5] Poulad, Payam, Status and role of research activities in the strategies of achieving the required technology for the Country, Issue 10, September 1994
[8] Reverse engineering as a way to encompass the principles of design, Payam Iran Khodro, Issue 46, July 2000
[9] Reverse engineering (a necessity), Science and Technology Service company in Tehran, Sana’ Khodro (automotive), Issue 22, September 1999
[10] Nateg, Mohammad Javad, Cheap funding as an effective supportive method of government from the national technology development, Industry and Development, Number 16, October 1997
[12] Dr. Seyed Mohammad Hossein Hojati, Abbas Taleb Bidokhti