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SELECTION OF TECHNOLOGY AND ITS ADAPTATION

Japanese Experience [1]

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Contents

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Selection of technology suitable for a corporation is a controversial subject since it is the function of the position and environment in which the corporation operates and the factors affecting such operation. There is no one set of rules to apply to all cases.

In this paper the actual practices of the average Japanese firm in the selection of technology and project planning are discussed with emphasis on its bearing upon the corporations operating in developing countries.

I. Level of technology

One of the key issues frequently discussed in the intercountry transfer of technology is the level of sofistication of the technology transferred. Developing countries usually want to acquire the most advanced technology while the doners of technology often indicate reservation on such attitude contending that the sofisticated technology often costs more and beside it does not help alleviate the serious unemployment or underemployment problem which most of the developing countries suffer.

Both sides have logic in their arguments. The reasons on which they base their insistence may be roughly classified as follows:

(1) Reasons to discourage introduction of most sofisticated technology

a. Sophisticated technology costs more and thus it is economically unprofitable.

b. To practise most advanced technology requires the back-up of the advanced technical skill, high quality material and parts and large amount of capital, which are often unavailable or very costly in developing countries.

c. Infrastructure required for plant construction is lacking in developing countries.

d. Most advanced technology in many cases is less effective to solve the question of unemployment or underemployment which developing countries often suffer, because it is designed to save labor cost which is high in developed countries.

e. Most advanced technology frequently requires the import of materials and supplies and it is not always designed to utilize the resources readily available in the developing countries.

(2) In contrast to the above argument, those who encourage the employment of most advanced technologies insist on the following:

a. No body wants to buy an old model especially if the price is almost same as that of the latest model.

b. By using less sofisticated technology and those considered obsolete in developed countries, the developing countries always remain in the developing stage.

c. Most advanced technology will after all contribute more to the countries national income, regardless of its social effect of employment. In short-term, labor intensive technology may contribute to the national

benefit by creating new jobs but for long-term, it will not contribute to the economic self-reliance of the country. Developing countries should somehow leap the technology gap.

d. Less advanced technology does not help the developing countries to compete against the products made by the advanced technology in the international market.

e. Most advanced technology is required for the prestige of the country.

The answer to these questions is a matter of relativity. If the developing country needs the technology solely for creating jobs for the people, less sofisticated labor-intensive technology may be preferred.

However if the country wants the technology for expanding its export by competing in the international market by processing its own material resources, naturally, it will need the more advanced technology which can produce the product at the cost competitive in the unproptected international market.

It must be born in mind that the employment of less advanced technology and resulting higher cost of production may penalize the domestic industries which use such products as their feed-stock and export their products to the international market. Even when the products manufactured are not exported directly the industries which use such products as raw material may be competing in the international market.

One thing which must be kept in mind however is that the sofisticated technology does not always promise the lowest cost of production. For example, the sofisticated plant may be harnessed with the complicated set of electronic circuits as labor saving devices and the frequent adjustment and repairing of the circuits may be more costly than to substitute it by manual labor.

Generally speaking, however, the employment of more sofisticated, mechanized system gives higher return on a unit man power and even taking into account the disbursement of large amount of capital fund required for construction of such system, it usually gives lower cost of production, provided that the corporation has sufficient technical staff and skilled labor who can digest, manage and control the said system. For example, in the agricultural production, United States is the world's most competitive producer of grains simply because of its highly sofisticated and mechanized farming. A statistic shows that the U.S. grain production is 1.5 times as large as that of People's Republic of China and twice of USSR while the number of farming population is only 1/8 of USSR and 1/65 of People's Republic of China and United States is the most competitive producer of grain in the world.

After all the level of sofistication is not the basic criteria for the selection of technology. What is more important is whether or not the

technology brings the largest return on the invested capital on the part of private firm and on the part of national economy.

Hereunder are discussed the factors which are taken into account in the selection of technology as practised by the average Japanese chemical firm.

11. Selection of Technology

Technology suitable for one's operation is selected from various viewpoints. There are numerable factors to be taken into account in the selection process but they may be grouped into the following eight categories, namely, product demand, availability of material including utility, process characteristics, equipment cost (investment), license conditions, environmental factors, safety and economic feasibility. The factors to be considered in each of these categories are detailed hereunder.

1. Product demand

The company which attempts to go into a new venture must first check if the product to be manufactured is suitable for the market, for the company, etc. They should investigate such factors as;

(1) How does the product compared with the countertype products offered by other companies quality-wise and cost-wise.

(2) How does it compare with the products that are already being manufactured and/or sold by the company, quality-wise and cost-wise.

(3) What is the possibility of utilizing the company's existing market channel in the distribution of the product in question. Consideration should also be paid to the possibility of marketing it in combination with the marketing of other products of the company (systematic sales or diversification of product grades).

(4) Magnitudes of technical service and application research necessary for the marketing of the product.

(5) Magnitude of the effort required for market development. Does it really have the market in the country?

(6) Estimated size of the market. Does the market grow in proportion to the development of economy of the country?

(7) Stability of the market. Is the market for the product only temporary or is it the lasting market?

(8) Possible applications of the product. What is the life of the product?

(9) Does the product satisfy the existing laws and regulations regarding safety? The regulations on the control of products from the viewpoint of their toxicity to human health and their ecological impact are becoming more and more the important factors in the selection of technology. This also applies to the process selection criteria as detailed later.

(10) Compatibility of the product with national economic policy and social policy

Is it in the list of preferred items? Is any subsidy or tax benefit given to the manufacture of the product?

(11) How does it relate to the long term development program of the corporation? Does it fit to the overall corporate strategy?

Based on the results of the survey on the above factors, the total effective demand for the product is estimated and the possible production scale of the product is determined.

2. Material and Utility

The availability of raw material and the stability of its supply are also the key factors in the selection of technology.

(1) Can the material be manufactured or supplied by the company? If so, should it be necessary to construct a new plant for the manufacture of such raw material or the surplus capacity of the existing plant may be utilized? Could it be produced together with other products? If the currently wasted by-products or the by-products sold to outside at unreasonably low price could be utilized, it is most advantageous.

(2) If the material must be purchased from outside, what is the capacity of production of the supplier? How many possible suppliers exist? What will be the demand and supply balance of the product in the future? The material may be supplied cheaper if the vendor can fill up their surplus capacity or can get rid of their surplus output.

(3) If the material must be imported; What will be the availability of the material in short and long term? What will be the capacity of supply? What is the perspective demand and supply situation in the vendors country? What is the political

situation in vendor's country? What is and will be the political and economic relationship between the vendor's country and recipient's country? What will be the freight in short and long term? Can the material be transported overland and oversea without undergoing deterioration of quality?, etc.

(4) What is the current price of the material and its future prospect?

(5) What is the safety of the material to human health and environment? Isn't there any possibility of legal control over the supply of material?

The above are the main factors to be considered in relation to the material.

3. Process

Checking points in the selection of the process are as follows:

(1) Competitive processes developed by other companies

Is the process to be licensed competitive with the processes now in operation by other companies? What advantage and disadvantage do they have respectively?

(2) Patent position of the licensor

Is the process covered by patents effectively and in what country? What is the validity and coverage of the patent?

(3) Infringement on patent owned by third party

The possibility of infringement on the patent of the third party must be checked carefully not only in the country of manufacture but also in countries of important overseas market.

(4) Commercially proven process

Examine if it is already used successfully in the existing commercial plant of proper capacity, because the scale-up work to the commercial size plant often involves risks. Also check if the scale-up work can be done by the licensee itself.

(5) Engineering, construction and operation

Check if the basic or detailed engineering, construction work and operation can be made by the licensee per se. Examine the extent of technical service and training that should be procured from the donor of technology.

(6) Familiarity of the process

If the licensee is already in practise of a similar or related process or has enough knowledge or affinity to such a technology to be licensed, it would be of a great help for the project.

(7) Optimization and further development

The technology to be licensed must be adjusted to the local conditions for the optimal operation and be developed further. Check if the licensee is in a position to carry out such work. (See also Section III)

(8) Adaptability to the climate and natural condition

As the case may be, air and water temperature or atmospheric pressure wields the influence on the operation of the process.

(9) Working safety

Checking of safety is naturally important. Also study the countermeasures, if any, to the hazards involved.

(10) Raw material balance

Never fail to consider the influence it gives on the process economics.

(11) Utility balance

Seasonal influence must be also examined.

(12) Quantity and quality of plant operators and analytical staff

Check the new recruitment and the transfer possibility from other existing plants.

4. Plant & Equipment

(1) Plant location

Select a candidate plant site and make the comparison in regard to the local pollution control regulation, transportation cost of raw materials and finished products, etc.

(2) Plant construction period

How long does it take to complete a plant? Is it too late or early for market development?

(3) Plant construction cost

Be sure to consider the construction cost of outside the battery-limits, too.

(4) Engineering job

Study the comparative advantage to carry out the engineering work by licensee itself or to employ outside engineering company.

(5) Procurement job

Who should buy the equipment, licensee or constructor?

(6) Construction

Study if it is better to make the construction of plant by the licensee or to employ the construction company. In the latter case, examine the work of scope they should do, for example, whether the civil work is done by licensee or outside company.

(7) Equipment of special design

Equipment of special design often involves difficulty in procurement and erection work.

(8) Imported equipment

Check carefully the cost (duty, insurance premium, freight, etc. to be eventually added), delivery term, availability of spare parts, etc.

(9) Maintenance work

Can the maintenance work be carried out by the personnel of the repair shop the licensee has at present? Is it necessary to ask for the service of outside company?

5. License

The conditions of the license of the process are also the important factors in technology selection. The potential licensee should check the following points.

(1) Scope of agreement: Does the scope of the license sufficiently cover all necessary technical know-hows and patents to enable the licensee manufacture use and sell the products?

(2) Royalty: Is royalty rate reasonable for the estimated return on investment and is it reasonable in comparison with royalty rate offered by other potential licensors.

(3) Territory: Does the contract authorize the licensee to operate (manufacture, use and sell) in the territory large enough to make the project feasible and profitable? The possibility of future export should also be taken into account.

(4) Guarantee: Does the licensor give you guarantee for product quality, performance of the plant and patent infringement? If not to what extent the licensor vouches to assist you when you are in trouble. Do your engineers have confidence in successful operation of the plant without guarantees?

(5) Exclusive or non-exclusive

If the license is exclusive, the possible competition by other licensees and resulting decrease of market price should be taken into account in the study of project feasibility and economy.

(6) Sub-license

Does the agreement grant you sub-licensing right? In some cases, sub-license may be an indispensable condition in the development of market.

(7) Possibility of future development

To what extent does the licensor give you the freedom for R & D and freedom of exploitation of the result of your R & D?

(8) Grant back

Are you required to feed back all new developments and discoveries to the licensor? Impact of anti-trust laws should be taken into account.

(9) Scope of technical assistance

Does the licensor agree to extend to you sufficient technical assistance in the designing, construction and start-up of the plant as well as in the future improvement of the process?

(10) Secrecy obligation

How long does the licensee's secrecy obligation last? Too long secrecy obligation may hamper the licensee's future overseas operation.

(11) Trade mark

Does licensor's trademark have real commercial value? If so, do they allow you to use it and on what conditions?

(12) Prohibition of the manufacture of competitive product

If such prohibition is imposed, doesn't it adversely affect to the other activities of your company?

(13) Legal requirements

Do the contents of the agreement satisfy legal requirement of the country? - Particularly those pertaining to anti-trust laws.

(14) Reservation of right after expiration of agreement

This relates mainly to the licensee's right to continue manufacture, use and sell the product after expiration of agreement and licensee's secrecy obligation.

6. Environmental Factors

In recent years, the consideration of the impact of the industrial activities on the environment has become very important factor. In some cases, it is a paramount factor because a process may be totally unpracticable due to its ecological impact. Law also prohibits the manufacture and sale of certain products or requires harnessing of anti-pollution devices which may call for substantial investment and thus deteriorates economic feasibility of the process.

It is advisable to collect the data and information, if available, on toxicity or any hazardous effect of the material to human being, cattle, poutry, crops, air and water.

The factors to be considered in this category may be as follows:

(1) Possibility of pollution by the product and its waste and possible countermeasures.

(2) Possibility of pollution by by-products and plant effluents and its countermeasures. Property and amount of such effluent as exhaust gas, waste water and waste liquid should be scrutinized. Method of treatment and possible investment cost for the treating facilities should be studied.

(3) Possibility of public nuisance caused by the plant, such as noise, odor, smoke, dust, etc. should be studied together with the method and cost of prevention of such nuisance.

(4) Possibility of pollution caused by various effluents in case of emergency, start-up and stopping of the plant should be studied together with the method and cost of prevention.

(5) Particularly, careful examination is recommended on the following items when they are discharged from the plant.

- Mercury, arsenic or compounds containing such toxic elements; BOD, COD; dust; suspended solids; SO_2, NO_x

Based on the above data, the total assessment of process should be made from the viewpoint of its environmental impact.

7. Safety

Safety assurance should naturally be taken into account not only for the smooth operation of a plant but also to minimize the hazard.

(1) Safety in plant operation

The following information must be obtained to assure the safety in plant operation.

a. Chemical and physical properties of the material

- inflammability, corrosiveness, etc.
- acute and sub-acute toxicity to those who may be contaminated by the material in the working area

b. Operation condition and equipment durability

- high pressure or temperature to be experienced in normal or abnormal operation
- durability of equipment against pressure or corrosion.

(2) Required safety measures

Based on the above information, the following protective measures should be taken.

a. Maintenance or repair work of the plant

It is advisable to inspect each equipment regularly to examine its durability.

b. Precautionary steps and procedure to be taken against emergency or accident.

c. Training of operators for routine operation

Most of the accident experienced in the past came out of mis-operation due to the lack of skill and attentiveness of operators.

8. Economics

Last but certainly not least the project economics is the major factor to be considered in technology selection. Project economics is usually based on the Return on Investment or R.O.I. which is usually made in the following manner.

(1) Estimate of annual sales in value and volume for certain years (preferably for the life of the equipment depreciated)

(2) Estimate of costs to be incurred annually

For the calculation of costs, the following items are taken into account.

a. Variable costs

Raw materials; Amount of consumption increase of raw material cost should be considered.

Utilities; power, water, gas, fuel oil, steam

Annual running royalty; if any

Other variable costs; Packaging, transportation costs, etc.

b. Fixed costs

Repairing maintenance expenses; These expenses usually run about 3% of plant cost and they are counted as fixed costs.

Labor; Work force may be laid-off or newly employed and pay scale may change year to year and it is available in that sense but for many industries including chemical industries, it is fairly fixed and do not vary in proportion to the level of production.

Depreciation; Depreciation of equipment, building, etc. The period and the way of depreciation may vary from one country to another. Either straight line method or declining balance method is usually employed for depreciation of equipment and machinery. Engineering fee and installation costs are also depreciable as a part of equipment cost.

Amortization; Initial expenses to be incurred before the commercial operation is amortized in given years. Training costs, start-up costs, lump sum license fee are included.

Plant overhead; This includes the investment and running cost of offices, guards, fire stations, etc.

(3) Annual selling and overhead expenses; Sales commission, administrative expenses.

(4) Annual interest; Interest is dependent on the amount of fund borrowed and its interest rate.

Annual profit is then calculated as the balance of sales and total costs.

$$(1) - |(2) + (3) + (4)|$$

The ratio of the annual profit as against the total fund invested is the R.O.I. of the project. To visualize the economics of the project, the cash flow of each year is discounted by interest rate into the present value. (D.C.F.)

III. Adaptation of TEchnology

The purchaser of a technology will have to adapt the process or products to the existing production line; the requirement of law, market need, etc.

1. Adaptation to its own production line

As detailed in Section II, the purchaser of technology often modifies the process in such manner that it best fits to his existing operation. If idle capacity of the existing plant is utilized for the practise of licensed process, the process will undergo substantial modification but with the risk of no-guarantee by the licensor. If the process is not commercially proven, a major development work will be necessary at substantial cost. Adaptation to the given climatic conditions is also a factor.

If a substitute material is abundantly available at low cost, the feed stock may have to be changed, again at the risk of licensor's guarantee.

The purpose of adaptation of process is after all the optimization of operation in a given environment.

2. Adaptation of product to the market

It is a well known fact that a product is quite successful in one market but is not at all in another market. It is important to modify the product property to suit best to the nature of a given market. Careful market study is

necessary to find out the product form most preferred in a market. For example, a product packed in a plastic bag may be far more successful in one market than the same product packed in the paper bag simply because the consumers want to utilize the waste bag.

3. Adaptation of process or product to legal requirements

In a country like Japan where pollution control law is extremely strict, a process may entail an unexpectedly large investment to satisfy pollution control law. For example an unusually keen public resistance to chlorine and mercury has almost completely ruled out the possibility of industrialization of many processes using mercury and the products containing chlorine. Or a plant emitting colored fume will have to discolor the fume not because the fume "is" toxic but because it "appears" toxic.

Most of these factors are already studied in the stage of selection of technology but according to the changing market need, legal requirement, etc. it requires constant review to adapt a given process to the environment where a corporation operates.

It is out of such effort for adaptation that a corporation gains new knowledge or develops new process or product which licensor may not have thought about. The feedback of such new knowledge, new product and new process is an important reward for the licensor under license agreement particularly when the licensee has greater potential for re-development of the licensed technology.

IV. Sources of Information on Technology

There are several sources of information concerning new technology. The foremost source is the Patent Gazette. Among the other sorces are engineering and industrial research organizations, private firms, government research institutions such as NASA, educational institutions and consultant firms. Also other sources include private publications which introduce published patents.

Another important source is technical and trade publications. For example, for the chemical industry, among the leading publications are Chemical Week, Chemical Engineering News, Chemical Marketing News, Journal of Commerce and Wall Street Journal. A list of publications subscribed to by one of Japan's largest chemical companies is attached as Exhibit I.

Another source of information is personal contacts. Company personnel travelling on business and representatives of companies posted to other countries often obtain important information concerning new technology.

If the company is seriously interested, it may send its technical personnel to visit the particular firm having the technology to seek additional information. In the advanced stages of acquiring new technology, this procedure is perhaps the most effective means.

By the same token, visitors from other company may also be an important source of information.

Japan's trading firms are another important source concerning new technology and products. These firms have worldwide business networks and in the course of their daily operations they frequently come across new information and data.

Engineering firms also have considerable knowledge concerning available technology. Generally they will undertake, on a fee basis, search for the most suitable technology according to the needs of the seeking company. Engineering firms which conduct international operations are often excellent sources of information.

In some cases, companies develop a new technology which they themselves find impractical to utilise. In such cases the company could bring this information to the attention of potential users thru various means.

One means is through the Licensing Executive Society. This is an international organization which includes among its members licensing managers, attorneys and other persons involved in licensing activity. The society is an excellent vehicle for technological exchange.

Another source are consultant firms which specialise in the exchange of information covering new processes and products. A leading American firm in this field utilizes computers for mass exchange of information.

Exhibit I

Agricultural Chemicals

American Dyestuff Reporter

Angewandte Chemie

Automotive Engineering (The SAE Journal)

Chemical Age International (London)

Chemical Engineering

Chemical & Engineering News

Chemical Engineering Progress

Chemical Industry Notes

Chemische Industrie (Düsseldorf)

Chemistry and Industry (London)

Chemie-Ingenieur-Technik

Chemtech

Chemical Marketing Reporter (O.P.D.)

Chemical Week

Control Engineering

Erdöl und Kohle

European Chemical News

Euro plastics (Brit. Plastics)

Farm Chemicals

Hydrocarbon Processing

Industrial Engineering Chemistry

- Product Research & Development
- Process Design and Development
- Fundamental

Industrial Minerals

International Dyers

Journal of Agricultural and Food Chemistry

Journal of Applied Polymer Science

Journal of Cellular Plastics

Journal of Polymer Science

Journal of Society of Dyers Colourists

Kunststoffe German Plastics

Kunststoffe und Kautschuk Fasern

Light Metal Age

Modern Packaging

Modern Plastics International

Nitrogen

Oil Gas Journal

Petro Chemical Engineering

Polymer Age (Plastics Rubber Textile)

Polymer News

Process Technology International

Research Management

Rubber Age (N.Y.)

Rubber Chemistry and Technology

Rubber Journal

Rubber World

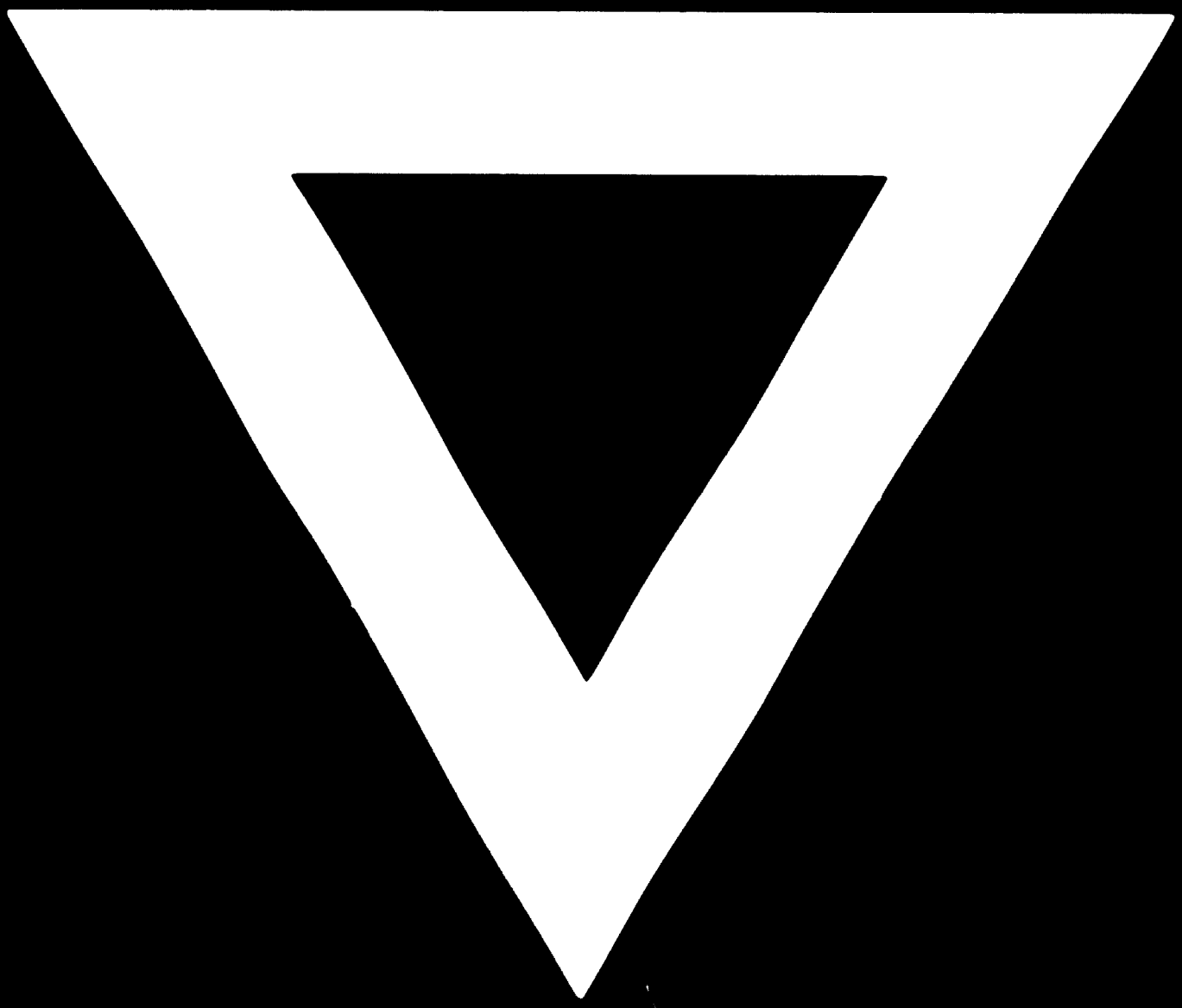
Soap Cosmetics Chemical Specialties

Plastics Engineering (SPE Journal)

Journal of Patent Office Society

List of Italian Chemical Patent

Official Gazette



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