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# **INTERNATIONAL FORUM ON APPROPRIATE INDUSTRIAL TECHNOLOGY**

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**WORKING GROUP No.1**

**APPROPRIATE TECHNOLOGY  
FOR  
HEAVY INDUSTRIES**

.....  
**LARGE-SCALE PROCESS EQUIPMENT AND APPROPRIATE TECHNOLOGY**  
**Background Paper**

**LARGE-SCALE PROCESS EQUIPMENT AND  
APPROPRIATE TECHNOLOGY**

by

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The description and classification of countries and territories in this document and the arrangement of the material do not imply the expression of any opinion whatsoever on the part of the secretariat of UNIDO concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries, or regarding its economic system or degree of development.

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The LIMA's Declaration gives a privileged place to process industries (1) in the industrialization of the Third World

Four years after the second meeting of ONUDI on industrialization, it appears, in the facts, that these industries became one of the stakes of world-wide industrial restructuration. The conditions of their development in the Third World are not yet clearly defined.

Several reasons could be considered ; one of them concerned capital goods and their technology : the world development of these industries lays on large exports of capital goods, 90 milliards US \$ in 1975 (2) with 54 for specialized equipment only (3). These exports make them a central element in the adjustment policies of the industrialized western countries and the multinational firms in front of the new main ideas of international relationships.

If the fact is not new (the table 1 concerning some electrical equipments during the period 1970-1973 shows it), it moves on and explains the new aims of multinational firms :

- To recover the petro-dollars and the other incomes draught from the raw material prices increase , cf. table 2 where the cost of the turn-key plants equipment exported by JAPAN increased about +100 % (refinery plants) to +215 % ( fertilizer plants) between 1972 and 1975 ;

- To conserve and to renew the control of technological evolution because technology leads to become (with the alimentary weapon) the only bargaining power of certains economies .

So, it is possible to understand that, according to estimates, the world's exports of capital goods for process industries might go increasing in the future, to reach 145-150 milliards US \$ in 1985 (CF. table 3).

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(1) For this study are called "process industries" the following industries  
electricity, oil refinery, petrochemical and chemical industry, fertilizer industry, food industries, metal-working industry, cement and ceramics industry.

TABLE 1

Part of the Third World in the deliveries of certain electric equipments of industrialized countries.

	I TRANSFORMERS > 10 MVA	II HYDRAULIC TURBINES > 10 MW	III HYDRO-ELECTRIC GENERATORS > 10 MW
United Kingdom	22	69	-
France	26,7	27,1	32,7
West Germany	9,5	90,5	77,2
Italy	22,1	42,2	44,2
Japan (a)	12	70	65
Switzerland	19,2	40,6	28,2

SOURCE : cf. (4)

(a) : the percents of the Third World concerning the deliveries of Japan are estimated by the author in terms of the part of the whole exports in the deliveries : 16,7 % for I, 78,8 % for II and 75 % for III.

TABLE 2

Price-index of equipment exported by Japan during deliveries of turn-key mills to foreign countries.

	1972	1973	1974	1975
Oil refinery	100	140	210	230
Petro-chemicals	100	140	120	250
Fertilizers	100	130	300	315
Cement	100	110	305	285
Refinery	100	130	180	200
Iron and Steel Industry	100	130	200	220

SOURCE : cf. (5)

TABLE 3

Valuation of world exports of "Industrial capital goods" by using sector between 1975 and 1985.

(in milliard dollars 1975 and %)

USING INDUSTRIAL SECTORS	VALUE IN 1975	YEARLY AVERAGE ACTUAL GROWTH RATE 1975-1985	VALUE IN 1980	YEARLY AVERAGE ACTUAL GROWTH RATE 1980-1985	VALUE IN 1985
Electricity (except nuclear)	12,0	1,8	13,1	2,0	14,48
Petro-chemicals					
Natural gas	51,6	5,4	67,08	6,0	89,77
Oil Refinery	8,4	4,5	10,46	5,0	13,34
Iron and Steel Industry-Metallurgy	9,6	4,5	11,96	5,0	15,26
Cement industries	8,4	6,3	11,40	7,0	15,99
TOTAL	90,0	4,8	114,00	5,5	148,84

SOURCE : cf. (2)

Consequently,

- to understand the evolutions of these equipments in terms of the multinational firms' practice,
- and to identify the conditions for a control of capital-goods' technology, for processing industries by developing countries,

are two analysis complementary levels for a reflexion on "Capital-goods and appropriated technology for developing countries".

This attempt is an experimental contribution in order to facilitate a debate between technology specialists and development economists.

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Like for the others industries, the development of appropriated technologies for the process equipment production appeared in the early fiftieths, and we can consider that the chinese position "We must analyse the imported equipments from foreign countries and observe the following phrase : utilisation-critic, transformation, creation" (6) has been also one of others national experiences, for example in INDIA or in NIGERIA (7).

All these attempts show the same characteristics and seem to have the same aims : to avoid the concentration of the production in some large units, to integrate these processes in rural development project, to increase local capacities of technical creation.

So, it is not surprising to note that the process equipments concerned by these experiences are principally those of food industries, cementeries, fertilizer plants and hydro-electric equipments. (8)

N.B : The broadcasting of informations on these experiences seems very restricted and limited to some research centers. To make easier the access to these informations by the formation centers, the local institutions of technical research or rural development might be then a priority aim to reach.

Whatever the importance of the works already effected may be, in some countries, however it appears that they did not cover the whole equipments process . The relative lack of Third World experience in the utilisation of some equipments and in the development of a capital-goods' industry, can explain this situation, even if these elements are not, like this will be prove, the only determining factors.

The large scale production, either a constraint bound to the available technologies or an aim to reach within some industrial policy, is a characteristic of these equipments (indicated subsequently by LSPE:large scale process equipments).

The current and future importance of the LSPE in the Third World industrialization leads then to center the analysis on these equipments with the view to valuate the conditions of the developing countries participation to the control of their technology.

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I EVOLUTION OF THE "LARGE SCALE PROCESS EQUIPMENT"

The LSPE evolution is generally characterized by their size, defined, for example, by their yearly production capacity or by their power (ex.: electric equipments).

This parameter, largely studied in the technical reviews and integrated in the classical economic studies under the meaning "scale economics", has a limited range : it hides the change of technics linked to the evolution of the LSPE required functions and sometimes the LSPE technology itself.

So, it would be necessary to show the functions required of the LSPE evolution, the part taken by the normalisation in the national and international spreading of this evolution, at last the medium term perspectives of change.

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If the process equipments size is an insufficient parameter for characterizing them, this information is a an indicator to approach the evolution of two functions :

- F. 1 : Mass transfers in the process unit,
- F. 2 : transports of produces out of the unit itself,

Other functions are to be considered :

- F. 3 : Efficiency of transformation operations,
- F. 4 : Speed of transformation operations,
- F. 5 : Reliability of the specifications of produces,
- F. 6 : Security of the operations.

NB : Nowadays, the energical economy leads to become a new function.

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F.1	The effects of the increase of the blooms and billets weight on the fabrication of the cranes and the electric engines which equip these cranes in iron and steel industry.
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F.2	The transport of electricity on long distances in progressive voltage (from 66 KV to 380 KV and more) compelled to change the isolators and the security equipments (for example : interrupters).
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F.3	The recovery of solvents in some polymerisation operations in the petrochemical industry required special control equipments' applications.
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F.4	The new wire-rod mills have a high rolling speed (finishing speed : 70-90 m/s) and consequently new equipments, chiefly for the stands (compact block with tungsten carbide rolls) and manufactured controls are used.
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F.5	The increasing automatism application in iron and steel industry is linked, between others reasons, to problems set by the respect of specifications more and more exact of products to deliver.
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F.6	The consequence of the increases of pressures, inside capacities and temperatures, is an increase of the thickness and an evolution to the use of irons little allied and even stainless steels. The thickness of used products are going to top 100 mm. (9)
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**TABLE 4** : Evolution of the LSPE required functions and evolution of the LSPE : a few examples.

Since 1955-1960, these functions evolution has direct effects on processing equipments, like the few cases stated in the table 4.

The changes in central equipments (for ex. : pressure vessels, generators, hydraulic or steam turbines, mills,...) and outlying equipments (pumps, compressors, valves, industrial furnaces, fittings, tubes and pipes,...) can be characterized by two elements :

- On one hand, the trend to uniformisation of production processes (cf. for ex. the part taken by MORGAN Company in the world uniformisation of wire-rod mills) (10) leads to the LSPE economic obsolescence, previously used, which reduces technologies to which developing countries could have access.

N.B. : This process is reinforced by the parallel evolution of industrial standards, cf. infra.

In consequence, the production process of uniformization leads to impose the kind of equipments to be used, giving the parameters of functions to assume (for ex. : equipping the wire-rod mills, two indicators are essential : weight of the billet and finishing speed) ; the direct consequence of this trend is to fix the LSPE production conditions.

- On the other hand, as far as the LSPE required functions become more and more precise, a LSPE differentiation tendency would be introduced.

This differentiation squares with the elaboration of specifications more and more compelling for a process or a determinated product , so much so, that in petrochimics (for example) sometimes, the owners of proceedings do give their guaranty on their proceeding only if their equipments are bought from such and such constructors.

Considering the LSPE development general tendency, it is possible to understand the evolution of both production and technology.

The analysis allows then to put in evidence five under-sets of technical evolutions which are always, by another way, interdependant :

- . the choice of materials,
- . the control of temperatures, and of heat treatments
- . the metal-working technics,
- . the conception of machines to produce the LSPE,
- . the controls of the production of the LSPE.

It may be possible to show, for each under-set, how and why the technical evolution and his internationalisation are not compatible with the LSPE industry autonomous development in the Third World.

An example will permit to illustrate this clamping. So, the standards fixing the choice of material in order to build the LSPE can be determinative for LSPE future in the Third-World. The problem is not new, and since 1960-1962, the ECLA's experts have defined clearly the terms of an essential contradiction in the self development of a LSPE adapted technology by the Third World :

*"If the project (petrochemical project) is prepared as a whole abroad, it will often contain raw materials which are specified in terms of the own characteristics of the country where the project is planned and which most often express the customs of producers and consumers of this country" (11).*

*"Actually, the foreign engineerers tend to specify the quality of raw materials and the design of the basis equipments so that they (the equipments) could be supplied by the high developed industries of their countries" (12).*

Since that date, the standards concerning the materials, their processing, their control, became more complex and more compelling, and even are the weapons used by the multinational firms (and by States) to organize a new international labor division ; so, for example, one can say that French industry has difficulties to follow certain evolutions concerning the materials and their using, for the production of several process equipment of the petro-chemical and chemical industries (13).

*"The firms or their engineerings, or their subsidiaries of industrial design began to offer their services to write the clauses of the supply-appeal, in such a way that they are then the most qualified to answer it. So, the supply-appeal is awarded even before to be started : the firms being inaware of these practices have learn it to their cost..." can write in 1976, the redaction of the review Business International (14).*

So the evolution of the LSPE required functions has several consequences for the Third World's countries which can be summarize as it follows :

1. the uniformization of fabrication process in the process industries leads to impose certain kinds of equipment by fixing the parameters of the functions to assume ; this creates the basis of economic obsolescence planification for technologies in case of a monopole of the process ;

2. the increasing differentiation of industrial specifications for each process or product made that the industrial specifications and industrial LSPE standards become determinative to favour or to stop the LSPE production of a given economy ;

3. the multinational firms try to conserve the control of the deliveries of the LSPE fixing the industrial specification of proceedings and equipments.

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The evolution recorded in the past, might continue during the next years :

- the part played by the specifications and the standards ought to increase as far as some equipments are standardized to allowe the decrease of their production cost ;

- but, on the contrary, the solution of the problems met by the market-oriented developed countries in order to restructurate their national industries and the interdependance relations between them react on the industrial specifications and the standards moving them more precise and constraining.

So, the raw materials' economy, the using of more performing catalyst (but with more unstable effects, the research of a higher efficiency in processes are going to carry necessarily :

. more performing irons' qualities used in the LSPE ;

N.B : The EEC provisory report on "Iron General Objectives 1980-1985" (Décember 1975) underlines the iron future evolution for the pressure levels, the stream and hydraulic turbines, the electric generators, the high power transformers, the pipe-lines (14).

. technical changes in the metal-working industry and in the special alloys metallurgical industries imposed by the increasing utilisation of titanium, zirconium, tungsten, molybden, etc...

. the increasing utilisation of micro-processors associated to very complex measure and control instruments (ex. : chromatograph) ;

. more strict specification for the fabrication of the LSPE, in particular for :

- the forge housing or the foundry moulds,
- the bits heating proceedings,
- the borings,
- the fabrication controls.

N.B : A fabrication control equipments' industry is developing, impulsed by the progress of the micro-processors, so much so in the fabrication of some electronic components, these equipments become strategic in the relations between trusts for this industry control.

In developing countries, the current and future policies to have a capital-goods industry and the struggles between multinational firms for the restructuring of their relations and the renewed profits, certainly are going to have direct effects on international labor division in the LSPE industry.

A certainty appears : multinational firms, and more generally the market-oriented developed countries LSPE industries, try to reinforce their control of the LSPE fabrication technics' evolution, and then of the formulation of their fabrication specifications and standards, of their fiability and their fonctionning.

This control allows them to prevent the severities of transfers technology's laws, thanks to a technical monopole, as the review "Business International" says :

*"Despite the increasing number of such decreets (that is to say on technology transfers), multinational firms always wide-awake estimate however that as far as they have unrivalled technologies, they can negotiate quitely to obtain better conditions than all these restrictions could let suppose". (15)*

This control also allows to renew, adapting it to current events, the practices described since 1960-1962 by the ECLA experts : the subsidiaries or joint-ventures settled in foreign countries guarantee the exports supported by a technical monopole or quasi-monopole :

*" In five years the exports of electric construction french enterprises have been increased of 170 % towards the countries where they have settled plants and of only 104 % towards the others..." (16)*

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Such a situation seems to let little place for a Third World efficient control on LSPE technics. However, this diagnosis attempt let appear clearly that for this kind of capital-goods, the development of adapted technologies is linked :

- to the will, already exprimed by some countries (cf. Algeria, Yugoslavia, India, China...) to control technology,

- to the ways and means that developing countries can set to link the development of their process industries and the creation of a capital-goods industry.

The first factor is dependent of debates between concerned social groups, and of choices, by them and by the Third World's states. The second, on the other hand, leads to produce the conditions of developing countries possible intervention in the LSPE evolution.

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II FOR A PARTICIPATION IN THE LSPE TECHNOLOGY CONTROL

The LSPE evolution analysis attempt allows to set the following hypothesis : LSPE technology appears like integration :

- raw materials specifications and energy transformation proceedings (ex. : polymerisation process ; non ferrous metal elaboration...)
- and advance of metalworking and assembly industries technics (ex. : heat treatment, machining, welding...).

Consequently, it seems difficult to promote LSPE technologies, without articulating technologies development ; but if this articulation is necessary, it is not sufficient : it is advisable to be able to control the choices of their own technological evolutions.

In that perspective, the part played by the process industries is determining :

Factor n° 1 : if the capital-goods industry is going consolidating in five countries (Argentina, Brazil, India, Mexico, South Korea), or only in embryo in 18 developing countries (a), process industries are already developed and must be largely till 1990 ;

Factor n° 2 : like ECLA experts showed since 1960-1962, current interventions of engineering consultancy firms or general contractors are determining in the facts the future equipment choices by mechanical engineering services.

In these conditions, the combinaison of factors n° 1 and 2 can have a contrary effect on adapted technologies promotion and increase the Third World technological dependance. Different technics can inhib then the articulation between equipment technologies and those of transformation proceedings.

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(a) ALGERIA	PAKISTAN	VENEZUELA
CHILE	PHILIPPINES	
COLOMBIA	PERU	
EGYPT	SINGAPORE	
HONG KONG	SRI LANKA	SOURCE : cf. (18)
IRAN	THAILAND	
MALAYSIA	TUNISIA	
MOROCCO	TURKEY	
NIGERIA		



The essential part played by construction and production specifications of process industries is yet to underline.

*"An illustrated example is given by the transformers load loss limitation : fixed with too narrow limits, they increase the used raw materials too, and with wider tolerances they allow a fall of the equipment cost higher than the exploitation cost increase". (19)*

Now, the semi-finished products used for guaranteeing a little load loss of the high power transformers are not yet elaborated in the developing countries...

Practically, the creation of a national engineering can allow to solve such contradictions if clear political and economical objectives define its tasks and its responsibilities.

In that perspective, and considering the technological obsolescence policy carried by the trusts, an engineering service in the Third World countries can have non assumed responsibilities in the market-oriented developed countries.

Two specific functions must be developed in particular :

- to memorize the technics and their evolution and the developing countries workers collective acquired,
- to analyse and to criticize the multinational technological and technical choices/discontinuities, in the sectors considered like priority.

#### FUNCTION N° 1

This function appears nowadays like absolutely necessary to solve problems linked to technologies obsolescence :

- some equipments are no longer built and can not be bought ;
- some standards are not applied and then the Know-How of their application disappears,
- some materials are not elaborated and the Know-How of their elaboration is not available.

The development of such a function will not accelerate the new international labor division, as far as

1) this memorization would be necessarily critic and would need it to liberate in each country, workers collective experience participating to the concerned industries development ;

2) the need of memorizing technics evolution is the problem of the futur if we consider contradictions between :

- the technological evolution impuled by necessity by multinational firms,
- and LSPE Third World technological policies supported by process industries projected in the developing countries.

This second argument must be illustrated and analysed because it creates a new function for an engineering service in a Third World country :

- What will be the new API and ASTM standards for the long pipe-lines when Third World tubing plants will produce ?
- What will be micro-processors standardization and consequently what will be international labor division for their conception and their production when developing countries will want to control them ?
- What will be cryogenic technics application to high power electric equipments (transformators, interrupters, disjunctors...) when countries like India, Algeria or Egypt will try to produce these equipments ?

#### FUNCTION N° 2

These examples are introducing technological or technical discontinuities cases to be developed in the future by multinational firms.

Now, process industries specifications uniformization let suppose the agreement by all the economic players of technological and/or technical new choices promoted for specification uniformization/internationalisation. In consequences :

1) il LSPE adapted technologies must allowe to avoid the specifications uniformization and its effects,

2) prevision and critic of next technical and/or technological discontinuities are necessary to propose alternative specifications to be created by developing countries themselves.

The function "Critical analysis of technical and/or technological choices/discontinuities impulsed by multinational firms" appears as a second function assumed by an engineering service with the view to promote LSPE adapted technologies.

But the multinational firms technical choixes are in the perspective of a new international labor division : oligopolist fights evolution have for effects :

- to standardize some LSPE which become opened to the 23 developing countries already quoted,
- and to create evolutive technological barriers with monopole development and consolidation.

The construction in Latina America of 6 direct-reduction plants using HYL process illustrates this double moving : the local production of standardized equipments (cf. Table 5) reach 100 % against only 25-30 % for the more monopolised equipments (catalysts, compressors, turbines and pumps).

This situation is not special to Latina America, and a study made on turn-key french plants exports (20) shows the same dependance towards american trusts for compressors and high power and pressure pumps.

For conclusion, it is possible to affirm the critical analysis strategic character of multinational firms technological choices : it is necessary to understand the long-dated function of LSPE adapted technologies with the view of new international labor division.

The other engineering functions are known ; it is not necessary to repeat them in this essay.

PLANTS EQUIPMENT	TAMSA	UNIT 1 PUEBLA	USIBA	UNIT 3 MONTERREY	UNIT 1 SIDOR	UNIT 2 PUEBLA
REFORMATORS	30	30	30	35	40	60
HEAT TRANSFER EQUIPMENT	0	30	25	35	50	90
REDUCTION REACTOR	80	90	80	90	10	100
PRESSURE RECEPTORS	80	90	80	90	100	100
IRON RESERVE EQUIPMENT	80	90	80	90	100	100
AIR COMPRESSORS WITH TURBINS AND PUMPS	0	15	20	20	20	25
CANALISATIONS	50	50	60	70	80	100
GENERAL ELEC. EQUIPMENT AND CABLES	80	100	100	100	100	100
CATALYSTS AND OTHERS CHIMIC PRODUCTS	35	35	35	35	35	35

**TABLE 5** : Latinò-american production of direct-reduction plants equipment, process HYL ( in percent)

SOURCE : cf. (21)

Different factors can influence negatively a technological policy development supported by preceding reflexions. In these factors, two are underlined :

- national normalisation and international economical relations possible constraints,
- multinational firms practices for technology transfers.

National standards choices linked to the potentialities of industries making LSPE and to states politico-économical objectives, is the priority expression of all effort with the view to articulate

- proceedings specifications,
- and metal-working and assembling industries know-how.

But the fixation of these standards and after all their application can be opposed by international economical relations.

#### POINT 1

If the process industry must export its production on the base of contracts of more than one year, the buyer requires supply guarantees. The seller asks then to reinsurance and insurance companies to cover rupture supply risks for technical reasons.

These companies try to lower technical risks to incharge, and asks for the more reliable standards application (API, and ASTM standards in petrol and petrochemical industries for example).

#### POINT 2

LSPE export is often an obligation to secure production capacities maximum using.

The fixation of standards/specifications different from those of the market-oriented developed economies constitute in that case an obstacle if the foreign buyer (ex. : electricity production companies, national oil companies, etc...) use ASTM, VDE, AIEE standards,...

The solution for such contradictions is possible only in the cadre of an industrial and economic regional cooperation (ex. : the role of ILAFA in the specifications fixing for the direct reduction iron ore).

Considering the precedent reflexion in these conditions, the development of adapted technology for the LSPE consist in industrial policy as a whole in the limits in which such a choice concern all the aspects of an industrial policy.

The restrictive practices of the multinational firms concerning the technological transfer seems as the consequence the more important obstacle against the development of LSPE adapted technology. The recent UNCTAD study on the brazilian electric equipment industry confirm that the restrictive practices are not only the fact of monopoles but also of cartels. (cf. (4)).

So any how it should be the technological choice that must be developed, by priority, for the LSPE in the developing countries, the industrial cooperation of the developed countries is necessary.

Today there are nothing as a global answer on the multinational strategy, there is only the possibility of these that are partial :

- the cooperation with the central planned economies (considering the experience of some developing countries)
- the cooperation with little and middle industries of western countries,
- at last, the extensive exchange of experience and informations between developing countries themselves, in spite of very restrictive practices of technology transfer prohibiting such acts most of the cases.

So, it is possible to consider that the appropriated technologies promotion for the LSPE needs the emergency of a "technic diplomacy" (22) which would confirm the hypothesis that such a technological choice by developing countries is a global choice of industrial policy.

These few reflexions propose some ways and means at the disposition of developing countries to participate to LSPE technological control . They show the existence of active possibilities, but their long-dated meaning for this countries industrialisation depends partly on those countries themselves : adapted technologies promotion has to be integrated in a global approach of industrial politic problems.

R E F E R E N C E S

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(1) In this study are called "process industries" the following industries :

- . electricity,
- . oil refinery,
- . petrochemical and chemical industry,
- . fertilizer industry,
- . food industries,
- . metal-working industry,
- . cement and ceramics industry.

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(2) "L'exportation de grands ensembles industriels : situation et perspectives".

EUROECONOMICS

Feb. 1978

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(3) "Bulletin des statistiques du Commerce mondial des produits des industries mécaniques et électriques".

NATIONS UNIES. 1975

The number of 54 US \$ is obtained adding up the world exports of products having the following SITC references :

711.1, 2, 3	718.4	719.15	729.92
711.5	718.51	719.11, 19	
714.2	718.52	722.	
718.1	718.13	723.	
718.3	718.14	729.5	

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(4) "Impact on developing countries of restrictive business practices of transnational corporations in the electrical equipment industry : a case study of Brazil".

by Miss B. EPSTEIN and Mr. K.R.U MIROW

UNCTAD/ST/MD/9 1977

United Nations Conference on Trade and Development



- (5) Les données économiques et techniques situant la compétitivité de l'industrie française de Mécanique Lourde.

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- (6) "Transfert de Technologie et Développement"

par P. JUDET, Ph. KAEN, A. CH. KISS, J. TOUSCOZ

Lib. Techniques, PARIS, 1977

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- (7) "La technique appropriée : Problèmes et promesses"

sous la direction de N. JEQUIER

OCDE Centre de Développement

(voir différents exemples)

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- (8) "La technique appropriée : Problèmes et promesses"

sous la direction de N. JEQUIER

OCDE Centre de Développement

(voir différents exemples)

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- (9) "Aciers Spéciaux : Monographies techniques"

N° 14 : Mise en oeuvre des Aciers inoxydables et alliages de nickel dans les appareils sous pression

par J. M. VASSAL

p. C.3.

Chambre Syndicale des Producteurs d'Aciers Fins et Spéciaux - 1964

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- (10) Rapport 3ème Symposium de MORGAN sur les Trains à Fils.

KYOTO - 22-25 avril 1975

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- (11) La fabrication de maquinarias y equipos industriales en America Latina"

I - Los equipos basicos en el Brasil

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- (12) La Fabricacion de maquinarias y equipos industriales en  
America Latina"  
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- (13) "L'industrie des biens d'équipement mécaniques et l'engineering  
en France et en Allemagne de l'Ouest"  
Tome 2 Nov. 1976  
par J. PERRIN B. REAL  
p. 74-77
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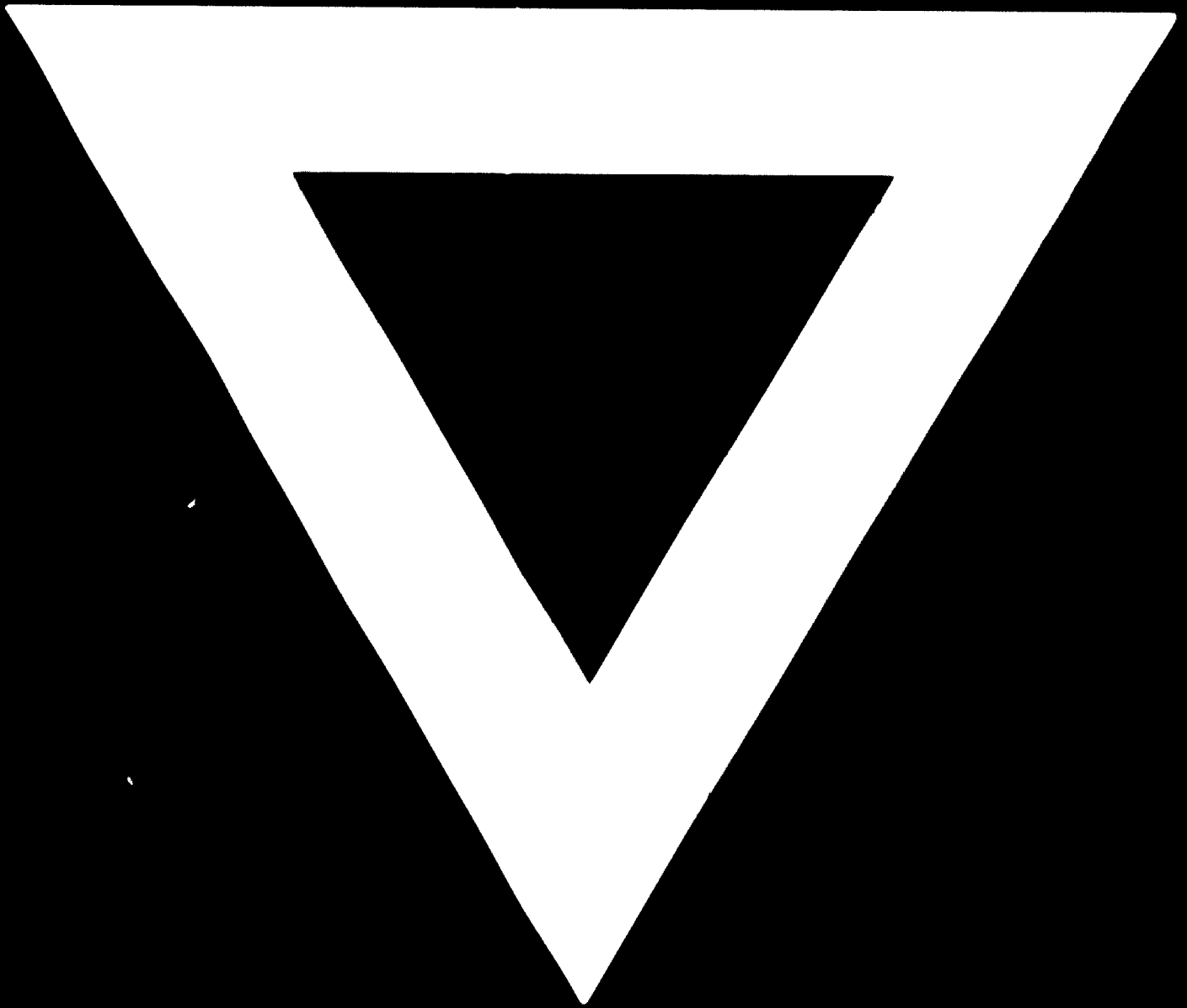
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Page 53



**B-37**



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