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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

**DEVELOPMENT OF THE
PLASTICS FABRICATION
INDUSTRY IN
LATIN AMERICA**

**Report of a Symposium
Lima, Peru
28 November - 1 December 1972**

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CORRIGENDUM

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**May 1973
Vienna**

**DEVELOPMENT OF THE PLASTICS FABRICATION INDUSTRY
IN LATIN AMERICA**

CORRIGENDUM

Page 2, line 3

For on a weight basis read on a volume basis

Page 9, line 18

For steel read cast

Page 21, 4th paragraph

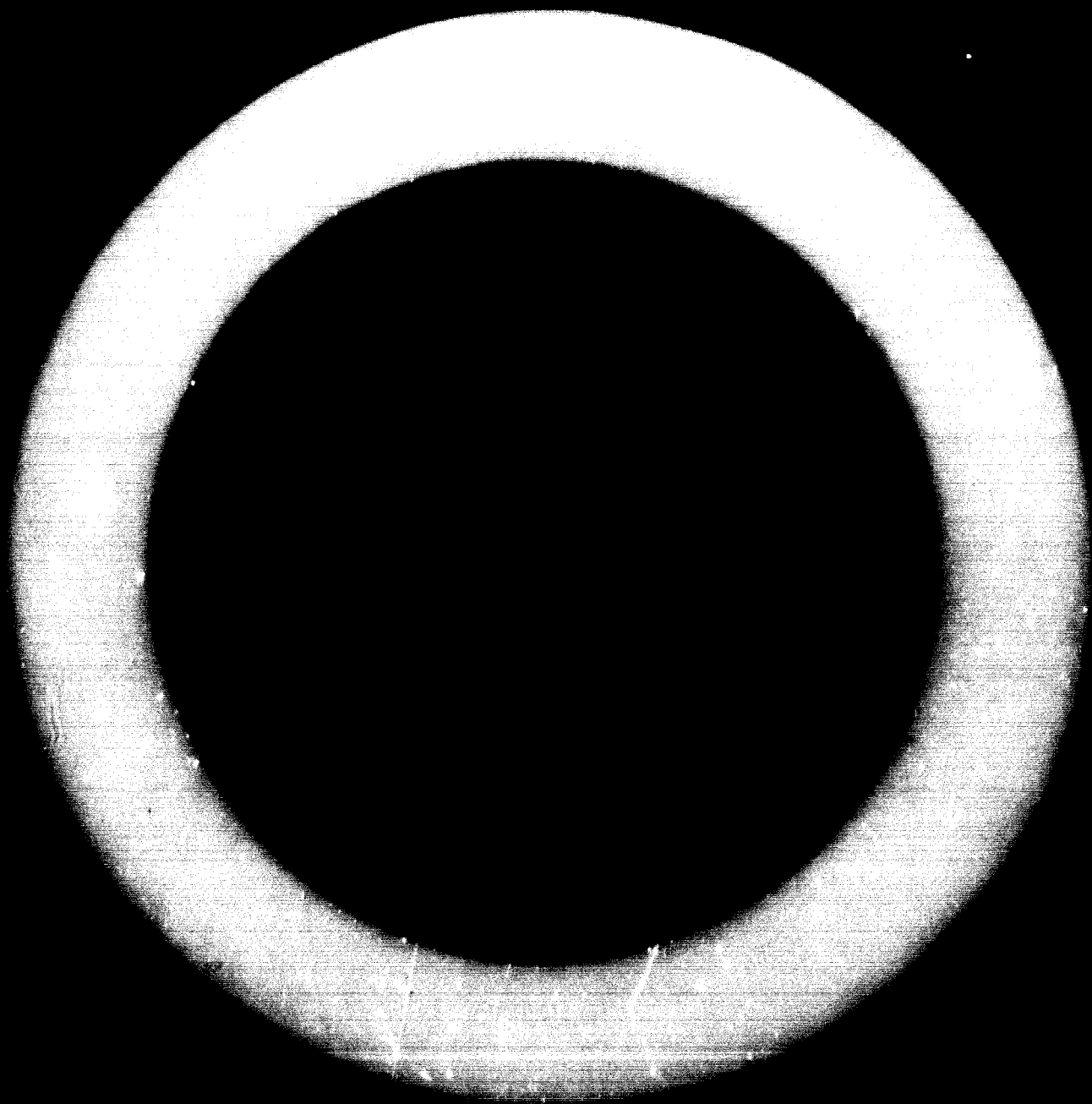
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In the course of the discussion, participants were reminded of the forthcoming international plastics fair, ARGENTIPLAS '74. It was suggested that facilities should be made available, possibly at I.C.A.P., which was located in Argentina, for training technicians. It was felt that advantage might be taken of the training courses organized jointly by UNIDO and the Austrian Government at the Laboratory for Plastics Technology (LPT).

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EXPLANATORY NOTES

Reference to tons indicates metric tons.

Reference to dollars (\$) is to United States dollars, unless otherwise specified.

In tables, three dots (...) indicate that data are not available or are not separately reported.

The following abbreviations are used in this report:

United Nations and other organizations

ACOPLASTICOS	Asociación Colombiana de Industrias Plásticas (Colombian Association of Plastics Industries)
ALIPLAST	Asociación Latinoamericana de Industrias Plásticas (Latin American Association of Plastics Industries)
AVIPLA	Asociación Venezolana de Industrias Plásticas (Venezuelan Association of Plastics Industries)
CACM	Central American Common Market
CALIP	Cámara Argentina de la Industria Plástica (Argentine Chamber of the Plastics Industry)
CARIFTA	Caribbean Free Trade Association
CIPA	Comité International des Plastiques en Agriculture (International Committee on Plastics in Agriculture)
ECLA	Economic Commission for Latin America
FAO	Food and Agriculture Organization of the United Nations
ICP	Industry Co-operative Programme of FAO
IFC	International Finance Corporation
ILAP	Instituto Latinoamericano del Plástico (Latin American Institute for Plastics)
INSTITIPLAST	Instituto Técnico Argentino de la Industria Plástica (Argentine Technical Institute for the Plastics Industry)
LAFTA	Latin American Free Trade Association
LKT	Laboratorium für Kunststofftechnik (Laboratory for Plastics Technology, Austria)
OAS	Organisation of American States
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme

Scientific and technical terms

ABS	acrylonitrile-butadiene-styrene co-polymer
Bisphenol 'A'	4,4'-dihydroxydiphenyl-2,2-propane
GRP	glass-reinforced plastics
MBS	methylmethacrylate-butadiene-styrene co-polymer
PVC	polyvinyl chloride
SITC	Standard Industrial Trade Classification
UV	ultra-violet

INTRODUCTION

The Symposium on the Development of the Plastics Fabrication Industry in Latin America, held at Bogota, Colombia, from 20 November to 1 December 1972, was the first in a series of regional symposia on this subject. It was organized by the United Nations Industrial Development Organization (UNIDO) in co-operation with the Asociación Colombiana de Industrias Plásticas (ACOPLASTICOS) and the Instituto Latinoamericano del Plástico (ILAP).

The principal objective of the Symposium was to assist the plastics industry of the Latin American region to achieve an orderly, efficient and rapid development in the production of plastics, their fabrication and use. World, regional, subregional and national trends in the production, consumption and application of plastics were considered. Specific aspects of the industry treated were: new plastic materials; developments in fabrication processes; production, management and organization of units to fabricate plastics; and applications of plastics to packaging, agriculture and housing.

Special consideration was given to the study of project proposals, and arrangements were made to facilitate confidential discussions among participants interested in investment promotion. Technological training in the fabrication of plastics and UNIDO technical assistance were also considered.

CONCLUSIONS AND RECOMMENDATIONS

1. The general situation of the plastics industry in Latin America

Plastics are among the basic raw materials essential for economic and industrial growth. In many Latin American countries the consumption of plastics has risen by more than 20 per cent per annum during recent years. World production of plastics, on a weight basis, is expected to exceed that of steel by 1980. Although at present only a few countries of the region produce petrochemical raw materials and intermediates, all of the countries represented at the Symposium had established plastics fabrication industries, whose magnitude and diversity in most cases bore some relationship to the size of the country's population. The smaller countries have relied heavily on the use of imported primary materials.

As the plastics industry is a major consumer of petrochemicals, its growth has a direct bearing on the development of the petrochemicals industry, which supplies over 50 per cent of the raw materials used in the production of plastics. Thus, the expansion of production and the increased consumption of plastics will have a significant effect on the development of petrochemicals in the region.

In view of the interest shown by Latin American countries in technical assistance projects, it was recommended that Latin American countries and UNIDO should work to complete the preliminary formalities and to implement as soon as possible projects that were identified during the Symposium.

2. Future Symposia

While it was agreed that the country papers were of high standard, to facilitate comparisons it was recommended that country papers for future symposia should conform more closely to the guidelines issued by UNIDO. They should place more emphasis on technico-economic problems and the measures to be adopted for their solution, and include quantified information on processing methods with the statistics' data on type and quantity of polymers produced and consumed.

It was recommended further that future meetings in Latin America should be held every two years, preferably in conjunction with national plastics exhibitions or fairs. The next meeting will be held in Buenos Aires concurrently with the colloquium on plastics in agriculture, which is scheduled to take place at the time of the Argentine plastics fair. UNIDO, the Comité International des Plastiques en Agriculture (CIPA) and the Instituto Técnico Argentino de la Industria Plástica (INSTIPLAST) are expected to co-operate.

The Symposium also recommended that assistance should be given by UNIDO in connexion with these seminars and fairs in Latin America.

3. Plastic materials and processes

It was noted that polyethylene, polyvinyl chloride (PVC) and styrene plastics continued to dominate the thermoplastics market in Latin America. The relatively newer plastics have so far succeeded in capturing only specialised markets of relatively low volume.

In view of the rapid growth and diversification of the plastic industry, it was recommended that some other countries in the region should consider the manufacture of plastics such as polypropylene, acrylics, unsaturated polyester resins, polyurethanes and acetal resins, which are produced by few Latin American countries.

A number of the papers presented underlined the importance of making adequate market studies prior to introducing new plastic manufacturing facilities. It was recommended that these studies include predicting the impact of the new products on the use of traditional materials. Where facilities for undertaking such studies were not available within a country, the services of other countries within the region should be obtained, especially countries that had had similar experiences.

In planning the further development of the plastic industry within subregions and individual countries of Latin America, it was recommended that special attention should be paid to the use of plastics as alternatives to scarce traditional materials, taking into account individual consumption patterns, which may vary from country to country. The vital role of import substitution in effecting substantial savings in foreign exchange was stressed as an additional motivation.

While conventional fabrication techniques have been widely adopted throughout the region, it was considered that many countries could benefit by introducing newer techniques. It was therefore recommended that the Latin American countries should consider introducing more modern fabrication processes, including injection blow-moulding, multiply-film manufacture, rotational casting, particulate (solventless) coating, monomer-casting, injection-moulding of thermosets, advanced thermoforming techniques and structural foam-moulding.

The Symposium agreed unanimously on the need to increase national and subregional facilities for research and development in plastics technology, to improve standards of efficiency and quality control, and to modernise facilities for product design, mould manufacture and maintenance.

It was recommended that the Latin American countries should:

Consider the feasibility of establishing national or subregional facilities for research and development in the technology of polymerization, fabrication techniques and quality control of finished products;

Consider the establishment of facilities for product design, and engineering shops for the manufacture and maintenance of moulds and dies on a national or subregional basis;

Establish norms for assessing efficiency. In this context, the use of efficiency ratings, as defined during the Symposium, was thought likely to prove useful.

It was recommended that UNIDO and the Organisation of American States (OAS) should continue in collaboration to search for and identify scientific and technological innovations and know-how, primarily in Latin American countries. Large, medium and small manufacturers of plastics should be encouraged to use the services of UNIDO and OAS in order to facilitate the transfer of technology and know-how from one manufacturer to another within the region. At the request of a Government, UNIDO might assist in locating potential investors through national or regional centres in Latin America to implement projects.

It was recommended that financing institutions, such as the International Finance Corporation (IFC) and the Inter-American Development Bank, should be approached for assistance in financing certain projects in the manufacture of plastics.

4. The applications of plastics

The most important fields of application, in which the potential for the increased use of plastics could be exploited, were considered to be agriculture and housing, in that they both contribute to fulfilling the basic human needs for food and shelter. In this regard, the efforts of the Working Group on Plastics in Agriculture of the Industry Co-operative Programme (ICP) of FAO, and UNIDO's initiative in studying the possibility of the mass production of low-cost plastic housing were noted. The latter project is in its early stages; its implementation requires feasibility studies followed by pilot-plant trials involving multi-industry co-operation with UNIDO and the Governments concerned. It was recognized that the success of this project would have a profound influence on the world development of the plastics industry and would be likely to generate more employment than that from the construction of houses by traditional methods.

It was recommended that UNIDO and ICP should provide technical assistance, especially to promote the continued use of plastics in agriculture in Latin America.

It was also recommended that the results of the feasibility studies and pilot-plant trials on low-cost, mass-produced housing from plastics should be made known as soon as they become available to the Latin American countries that are interested.

5. Training in plastics technology

The Symposium emphasized the importance of adequate training in all branches of the plastics industry. Provision of training facilities to personnel at existing institutes, such as INSTITUTE in Buenos Aires, was noted. Such training has been supplemented by visiting teams of specialists who have conducted seminars and provided consulting services to other Latin American countries. On two occasions they have been accompanied by UNIDO experts. Note was taken of the UNIDO training programme in plastics technology in co-operation with the Austrian Government and the Laboratory for Plastics Technology (LKT) in Vienna, and of the plant visits organized in Europe by the joint UNIDO-Romania Centre.

It was recommended that Latin American countries should continue to participate in such training programmes, and that in-plant training facilities should also be provided by established plants for manufacturing and fabricating plastics. The use of similar facilities at specialized institutions and plants outside the region was also considered important.

6. Specific problems of the plastics industry in Latin America

Many countries of Latin America have had difficulties in obtaining technological and economic information, expertise and adequate facilities for carrying out essential pre-investment activities. It was therefore recommended that more consulting organizations specializing in plastics be established in the region. These organizations could offer the services of highly competent specialists and other facilities for undertaking pre-investment studies, feasibility and detailed project reports, engineering design and construction, plant commissioning and operation, and research and development on new or improved processing techniques compatible with local conditions. The possibility of using consulting organizations as sub-contractors of UNIDO to undertake UNIDO technical assistance projects in the region might be considered.

It was recommended that UNIDO should:

Assist in establishing or strengthening regional and national centres to develop plastic technology, provide services to the plastics industry in training, research and development, application, engineering, quality control and testing, standardization, the design and construction of moulds, and technical services to plastics manufacturers, including trouble shooting, product improvement, up-grading technology and improving efficiency;

Help in the preparation of market studies, in close co-operation with regional, subregional and local organizations, on the application of plastics to building, agriculture, packaging and engineering, and in making pre-investment studies for specific projects and recommending consulting services within the region and from outside;

Aid in setting up a roster of Latin American experts to provide assistance to the countries in the region to be available on short notice under the UNIDO technical assistance programme when requested by Governments;

Guide in selecting processes, process licensors, engineering design and location of plants;

Advise in such matters as plastic waste disposal, including its use as a fuel, its reworking, chemical and bio-degradation and re-use.

The inadequate supplies of spare parts and the lack of skilled toolmakers was demonstrated in discussions, which clearly indicated the importance of plant repair and maintenance, the availability of sufficient spare parts, and adequate mould designs and mould making.

It was recommended that UNIDO facilitate studies in depth in these fields with a view to establishing national and subregional pools of spare parts and moulds, and to organizing a mobile team of experts to advise manufacturers on all aspects related to the plastics industry.

Difficulties were experienced in obtaining imported raw materials of adequate and uniform quality. Some participants felt that Latin America was being used as a sink for sub-standard products.

It was recommended that UNIDO, in co-operation with the Economic Commission for Latin America (ECLA), the Latin American Free Trade Association (LAFTA), and subregional organizations such as the Andean Group, the Central American Common Market (CACM) and the Caribbean Free Trade Association (CARIFTA), should develop a system for cataloguing plastic raw materials of specified qualities and fabrication processes that are available for licensing, and that, in co-operation with the United Nations Conference on Trade and Development (UNCTAD), UNIDO should provide data on supply and demand and imports and exports in the Latin American countries.

It was recommended further that UNIDO should provide assistance in studying the possibility of relocating plants manufacturing plastics from developed countries to countries in Latin America where local conditions were compatible.

I. ORGANIZATION OF THE SYMPOSIUM

The Symposium was attended by 231 participants from 20 Latin American countries and 14 countries outside Latin America. They included: 26 participants selected from the developing countries by UNIDO; representatives of private industry, government agencies, institutions of higher education, consulting organizations, and supporting trade and professional organizations; observers from private industry; and UNIDO staff and consultants.

Plenary sessions were conducted by the Chairman, I. Chiappe-Lemos, President of ACOPLASTICOS, and the Vice-Chairman, J.M. Aisenberg, President of ILAP, together with the Director, Co-Director and Technical Director of the Symposium and section chairmen, vice-chairmen and rapporteurs appointed by UNIDO. A ratifying committee, composed of UNIDO staff and consultants and officers of ACOPLASTICOS and ILAP, was formed to consider the draft final report, which was prepared in the course of the Symposium by English- and Spanish-speaking working committees.

The Symposium was inaugurated by the President of the Republic of Colombia, His Excellency Dr. Misael Pastrana Borrero. Messages from the Executive Director of UNIDO and the Director of the Industrial Technology Division of UNIDO were read by the Resident Representative of the United Nations Development Programme (UNDP) in Colombia.

Papers presented to the Symposium provided a review of world trends in the production and use of plastics. The over-all situation of plastic fabrication in Latin America was described by representatives of BOLA and OIQ. The status of the industry in subregional trade zones was discussed by representatives from LAFTA, the Andean Group and CACM. Developments in each of the Latin American countries represented were covered by country participants. Materials, fabrication processes and applications were dealt with in three sections on these specific aspects of the industry. Other topics covered included institutes for plastic technology, technical assistance, and investment promotion.

II. PLASTICS IN WORLD DEVELOPMENT

Technical papers dealt with current world trends in plastics fabrication, the role of leasing in financing and management, costing methods for new applications of plastics, and a description of the structure and functioning of OAS.

New materials under development that were described at the Symposium ranged from rapid-setting and high-temperature resistant polymer systems to polymeric conductors and semi-conductors. The newer techniques of fabrication embraced developments in such widely diverse fields as spun-bonding, film-formation, film-casting from polymer blends, fibre-formation from high-melting-range aromatic polymers and the preparation of polymer membranes for such applications as water purification. The influence of new developments on the consumption potential of established materials and of the newer polymers was considered. Samples of many of the new materials were distributed for examination by the participants.

In the discussion it was brought out that although many new developments had occurred as a "spin-off" from aerospace research, such research had not been the only source. Other developments had resulted from efforts of manufacturing organizations, especially multinational companies, and many had been stimulated by the demands of particular industrial sectors, such as the automotive industry. The new processing techniques for established polymers had two major aspects, namely, higher performance, such as in spun-bonding of polyethylene, and improved economics. At the same time, they tended to increase the rate of obsolescence of existing processing plant, thereby heightening investment risk. In this respect, it was emphasized that new and established processes could co-exist, and that potential investors could minimize risk by seeking technical and financial advice from such bodies as professional and consulting organizations or UNIDO.

Major trends in the production and consumption of the main plastic materials over the last decade were reviewed, and growth rates were compared on the bases of geography, materials and technical development.

Trends in plant capacities were discussed from the perspectives of the highly industrialized countries and of the developing countries. Although published figures for minimum viable capacities for monomer and polymer production were disclosed, it was emphasized that these could only function as general guidelines, and that many factors influenced decisions in considering investment in plant. It was suggested that a comparison of per capita consumption had greater validity when coupled with a comparison of average income; in this way the Latin American countries had made an improved showing.

The possibilities of leasing were proposed as a means of minimizing investment risk and of spreading capital investment costs over a longer period of time, thereby freeing more working capital and maintaining liquidity. The leasing of finance, real property and maintenance were described, and it was suggested that UNIDO act to co-ordinate the efforts of the developing countries for leasing investment. In a complementary paper on costing methods for investment, systems based on both investment costing and unit costing were described. It was suggested that, in order to compensate for errors in cost estimates, a minimum percentage return on capital should be in the order of 20 per cent, and 5 per cent per annum should be allowed on raw materials to offset inflationary tendencies. It was agreed that duplication of compensatory interest costs should be avoided in calculating the return on investment.

The contribution of GAS to the development of the plastics industry in Latin America was stated to include: the creation of an atmosphere favouring dynamic enterprises; the transfer of technology; the establishment of specialised regional and national centres; and social and economic studies. The establishment of a pilot project, in co-operation with UNIDO, for the transfer of technology was described as being currently in its formative stage. A number of participants expressed interest in this aspect, and relevant recommendations were drawn up and appear at the beginning of this report.

III. PRESENT STATUS AND FUTURE PLANS OF THE PLASTICS FABRICATION INDUSTRY IN LATIN AMERICA

Sixteen of the 20 Latin American countries participating in the Symposium were members of intra-regional trade associations. Two were members of CARIFTA. All trade zones of the region were represented. The participating trade zones and countries, with their population, are listed in table 1.

Table 1. Participating countries by subregional zones (Population in millions, 1972)

Zone and country	Population	Zone and country	Population
LAFTA		Andean Group	
Argentina	25.1	Bolivia	4.9
Bolivia	4.9	Chile	10.1
Brazil	98.7	Colombia	23.8
Chile	10.1	Ecuador	6.4
Colombia	23.8	Peru	14.5
Ecuador	6.4	Total	59.7
Mexico	98.7		
Paraguay	2.6	CACM	
Peru	14.5	Costa Rica	1.8
Uruguay	3.2	El Salvador	3.7
Venezuela	11.5	Guatemala	5.6
Total	254.9	Honduras	2.8
		Nicaragua	2.2
		Total	16.1
CARIFTA		Other	
Trinidad and Tobago	1.1	France	1.5
Guyana	0.8	Dominican Republic	4.7
Total	1.9	Total	6.2

The overall situation of the industry in Latin America

A paper presented by ECLA contained a comprehensive statistical survey of the trends in production and consumption for the major thermoplastics, thermosets and plasticizers in each Latin American country from 1965 to 1971.

Table 2 gives the over-all consumption of plastic materials, in the period 1965-1980 by subregional trade zones and countries participating in the Symposium.

Table 2. Over-all consumption of plastic materials by subregional trade zones and participating countries
(Thousand tons)

	1965	1968	1969	1970	1971	1972 ^{a/}	1975 ^{b/}	1980 ^{b/}
<u>Andean Group</u>								
Bolivia	0.9	2.0	...	...	4.5	...	10.8	64.5
Chile	...	38.5	...	50.0	62.4	...	...	257.0
Colombia	...	49.5	...	...	68.5	...	...	...
Ecuador	...	...	10.4	...	...	...	...	...
Peru	...	30.0	...	...	53.9	...	...	...
<u>CACM</u>								
Total	17.0	36.7	41.1	49.0	58.1	69.1	126.0	...
Costa Rica	4.2	8.6	...	...	...	...	...	...
El Salvador	4.3	8.1	...	...	...	...	...	...
Guatemala	4.9	8.0	...	...	...	...	...	...
Honduras	1.6	7.7	9.3	10.9	...	25.0	25.0	54.0
Nicaragua	2.0	4.2	...	...	...	...	...	...
<u>Others</u>								
Argentina	84.6	107.3	...	...	199.3	...	...	...
Brazil	104.6	221.5	...	...	379.8	...	...	...
Mexico	93.1	151.2	...	185.0	233.5	...	...	...
Panama	3.6	7.4	7.9	10.3	12.5	15.3	28.5	80.0
Trinidad and Tobago	...	3.8	7.7	7.6 ^{a/}	8.0	...	...	...
Uruguay	...	...	...	13.5	15.0	...	...	...
Venezuela	32.7	...	...	67.3	76.5	83.4	144.0	...

Notes: Statistics were not available for the Dominican Republic, Guyana and Paraguay.

^{a/} Estimated.

^{b/} Projected.

The total consumption of plastics in Latin America amounted to 1,242,200 tons in 1971, representing an average per capita consumption of 4.74 kilograms. The growth in consumption and production from 1959 to 1971 is shown in table 3, which also indicates the growth in the percentage share of plastics in the total production and consumption of chemicals.

Table 3. Growth of production and consumption of plastics, and their percentage share of the chemical sector, 1959-1971
(Based on 1959 values)

Year	Production		Consumption (apparent)	
	Million dollars	Percentage of total chemicals	Million dollars	Percentage of total chemicals
1959	65.4	3.5	147.0	5.0
1960	81.8	4.0	169.6	5.3
1961	100.4	4.4	201.7	5.8
1962	120.1	4.8	227.8	6.0
1963	156.2	5.7	285.7	7.0
1964	212.1	6.9	363.1	8.0
1965	252.8	7.7	423.1	8.7
1967	400.0	9.8	510.0	10.2
1971 ^a	1,000.0	16.5	1,250.0	14.9

^a Estimated.

The consumption of plastics for the entire region was distributed as follows: Argentina, Brazil and Mexico, 65 per cent; Colombia, Chile, Peru and Venezuela, 21 per cent; and Bolivia, Central America, Ecuador and Uruguay, 14 per cent. The major thermoplastics, namely, the polyolefins, PVC and polystyrene, represented 60 per cent of the total consumption of plastics. Production in 1971 reached 56.4 per cent of apparent consumption.

The need to establish a strategy for the development of the petrochemical and plastic industries was recognized by the participants, and it was felt that plastics associations, such as the Latin American Association of Plastics Industries (ALIPLAST) and ILAP, and appropriate United Nations organizations, might help in formulating such a strategy, possibly by being represented on a planning panel. It was also agreed that primary plastic raw materials imported into Latin America should be of adequate quality. Per capita consumption of plastics in Latin America was predicted to reach about 50 kilograms by 1985, which is a figure based on the rate of growth in Latin America independent of that for the rest of the world.

Latin American Free Trade Association (LAFTA)

The growth of the petrochemicals and plastics industries in the countries of LAFTA was given, together with forecasts of demand for Argentina and Brazil in 1975 and 1980. Per capita consumption of energy, expressed in terms of its equivalent in kilograms of carbon, and per capita generation of electrical energy were compared with the same figures for other countries in the world as a means of establishing the relative positions of LAFTA countries. From this comparison it was deduced that a gap of about 60 years existed between the Latin American and the more industrialized countries.

Andean Group

The present production of polymers was taken as an indicator of future prospects for the production and consumption of plastics by countries belonging to the Andean Group. Although current over-all utilization of capacity was fairly low - PVC-suspension polymer, 68 per cent; PVC-emulsion polymer, 64.5 per cent; low-density polyethylene, 38 per cent; polystyrene, 85 per cent - , it was expected that by 1980, unless capacities were increased, significant production deficits would have been incurred in the manufacture of these polymers. At the same time the demand for high-density polyethylene and polypropylene would have risen to 28,000 tons per annum and 25,000 tons per annum, respectively.

The discussion centred largely on the comparatively low current demand for plastics within the subregion. The reasons given included the low average per capita income of \$100 in 1971, high customs protection, and the fact that within the subregion the indiscriminate replacement of traditional materials by plastics offered no advantages in the form of reduced investment costs or higher utilization of labour.

Central American Common Market (CACM)

The current per capita consumption of plastics was 4.19 kilograms in 1970, and it was expected to reach 7.98 kilograms by 1975. Resin production had been stimulated by the establishment of an additional 10,000 tons-per-annum PVC plant in 1969. Such production also included

acrylic sheet, unsaturated polyesters, polyvinyl acetate and aldehydic resins, satisfying approximately 30 per cent of demand, which was about 45,000 tons per annum. Although intra-regional trading was active, exports to non-Latin American countries were negligible. The problems encountered by the Central American countries, namely, lack of training facilities, specialized experience, quality control and research facilities, and of skilled toolmakers and designers for mould production, were similar to those experienced by other Latin American countries.

Argentina

As a result of the active initiative of the Argentine Chamber of the Plastics Industry (CALIP), the country had experienced rapid progress since 1950. Working groups of the Chamber had contributed to formulating national legislation on the use of plastics for packaging foodstuffs, had established a commission for plastics in agriculture, and had organized a national congress to consider the employment of plastics in agriculture. CALIP had participated in international congresses in this field, and it was organizing the sixth international congress scheduled to take place in Buenos Aires in 1974. Institutes from both the Federal Republic of Germany and the German Democratic Republic had been represented at a seminar on "Progress in injection, extrusion and blowing" organized by the Chamber in October 1972. Primary raw materials had been produced in Argentina since the early 1950s, and the total consumption of plastics had reached 105,260 tons by 1971. Consumption was expected to reach more than 185,000 tons per annum by 1975. Growth rates in the consumption of acrylonitrile-butadiene-styrene co-polymer (ABS), expanded polystyrene, nylon 6, and polyester resin were expected to be maintained at 20 per cent per annum or higher.

In the course of the discussion, participants were reminded of the forthcoming international plastics fair, ABRUPLAS '74. It was suggested that facilities should be made available, possibly at ILAP, which was located in Argentina, for training technologists. Since ILAP was not equipped for training personnel, however, it was felt that advantage might be taken of the training courses organized jointly by UNIDO and the Austrian Government at the Laboratory for Plastics Technology (LPT).

Bolivia

The consumption of all plastics in Bolivia was expected to reach 3,704 tons in 1972, after a recession that had started in late 1968 had been arrested. Projections indicated that consumption would reach 11,810 tons by 1975 and 64,540 tons by 1980. It was thought that the introduction of more sophisticated technologies, involving higher capital investment, would be necessary to meet this potential demand. It was pointed out that the 1971 investment law of Bolivia would permit the importation of relocated plant, if it met the requirements for technical specifications.

Brazil

Despite increases in the capacity of the major polymer-producing plants, imports of resin had increased from 29,000 tons in 1966 to 120,000 tons in 1970. Most of these imports consisted of low-density polyethylene, which had been manufactured locally since 1971. It was expected that total production of the major thermoplastic polymers would be approximately 165,000 tons in 1972, a figure more than double that for 1970, but that an additional 129,000 tons would still need to be imported. With the continued growth in the petrochemical industry, it was anticipated that the plastics fabrication industry might become independent of imported materials. In addition to the manufacture of PVC, vinyl chloride co-polymers, polystyrene and high- and low-density polyethylenes, plans were being implemented for the production of polypropylene, polyethers and toluene diisocyanate. The production of ABS was expected to begin in 1973.

Chile

The per capita consumption of plastics had grown at an annual compound rate of over 20 per cent in five years, reaching 4.5 kilograms by 1971. The country had the capacities to manufacture 25,000 tons per annum of low-density polyethylene, 15,000 tons per annum of suspension-PVC and 9,000 tons per annum of styrene polymers. Plans were to expand production to include polypropylene (25,000 tons per annum), to produce an additional 10,000 tons per annum of styrene polymers, and to increase the capacity to compound

various grades of PVC from 3,000 tons to 9,000 tons per annum by 1974. Total resin consumption, including thermosets, was expected to reach 123,000 tons by 1976 and 232,000 tons by 1980. It was estimated that in order to develop the industry adequately, an investment of \$55 million would be required for the fabrication sector and \$60 million for the sector manufacturing resin. It was felt that UNIDO could be of assistance in selecting personnel and in obtaining equipment and machinery.

Colombia

Colombia had relied on significant imports to meet consumption demands, despite installed capacities for the production of 15,000 tons per annum of low-density polyethylene, 24,000 tons per annum of suspension-PVC and 6,000 tons per annum of styrene polymers. In 1971 the country consumed 44,190 tons of thermoplastic resins and 4,260 tons of thermosets, representing a per capita consumption of 2,2 kilograms. Exports of primary plastic materials represented approximately 7.2 per cent of consumption and 11.5 per cent of production. A policy to modernize industry, initiated in 1966, curtailed the vertical integration of the production and fabrication of plastic materials, which was thought to have discouraged free competition. This had made a significant contribution to the development of the plastics industry.

Costa Rica

As Costa Rica had a population of only 1.8 million, its participation in CACM, whose combined population totals about 16 million, had profoundly affected the country's market potential. The production of primary materials was limited to oil-modified alkyds - unsaturated polyester resins and acrylic sheet. Only 39 per cent of capacity was being utilized in the production of polyester resins, and 50 per cent in the production of acrylic sheet. Significant quantities of plastic materials, in the Standard Industrial Trade Classification (SITC) product group 599.01, were imported, mainly in the form of film, pre-formed blocks, profiles, laminates and tubes. By 1970, however, imports of primary thermoplastic resin were lower; for example, only 379.3 tons of PVC and its derivatives were imported in this year. Imports of plastic materials could, however, increase tenfold by 1980.

Dominican Republic

The Dominican Republic, with 4.7 million inhabitants, was not yet a member of a subregional trading zone, and its plastics industry was largely confined to thermoplastics conversion. The problems of the industry, consistent with the country's size and geographical situation, were technical and economic. It was felt that a significant contribution towards their solution might be made by UNIDO, particularly with respect to the technical aspects of processing plastics.

Ecuador

In 1969, nearly 1,000 persons were employed in the plastics fabrication industry of Ecuador, and 10,129 tons of primary plastic materials were imported. In 1971, however, imports had dropped to below 8,500, despite an increase in the demand for plastic products at a compound rate of 12 per cent per annum over the previous five years. The effect of the development of the petrochemicals industry in the Andean Group on the conversion sector in general would require detailed study before the industry in Ecuador would be integrated into that of the subregional zone; in particular, the way in which Ecuador might develop in relation to the subregion. The growth of the market would depend on the demand for new plastic materials and on possible production of polymers based initially on imported primary petrochemicals.

El Salvador

Since the plastics industry of El Salvador was fully integrated into the CACM, it was limited to the conversion of imported primary plastic materials. Since 1965, assistance from the OAS had facilitated the development of the industry, and plans had been drawn up to continue aid to the industry in Central America up to 1975.

Guatemala

As with other CACM countries the plastics industry of Guatemala was fully integrated into the subregional zone. It produced a comparatively wide range of plastic articles fabricated from imported primary plastics. In relation to the small size of the internal market, this inevitably led

inefficiencies, and the further development and promotion of the use of plastics was considered an important requirement.

Guyana

The plastics industry in Guyana was necessarily small, since the population numbered only 800,000 and opportunities for export to the countries in the Caribbean were limited. Five factories produced plastics. The largest of these manufactured plastics reinforced with glass fibre. The rest were concerned mainly with conventional fabrication processes, including injection- and blow-moulding.

Honduras

The consumption of plastics had increased by 100 per cent between 1966 and 1970, and the production of plastic items had increased by 200 per cent over the same period. The value of exports had increased by 168 per cent, and of imports, by 83 per cent. It was estimated that the value of consumption would be \$25 million in 1975 and \$54 million in 1980. Plans for future development depended on the initiative of the private sector, which was expected to continue to diversify and to install new plant.

Mexico

Although currently dependent on a certain amount of imported monomers, Mexico was becoming progressively more self-sufficient. The country had installed capacities to produce 72,600 tons of low-density polyethylene and 72,000 tons of vinyl chloride polymers, and had plants for producing polystyrene and polyvinyl acetate. In addition, by 1970, the country was manufacturing 28,500 tons annually of a comprehensive range of thermosets. Per capita consumption of plastics was 3.8 kilograms in 1970. Plans for the expansion of capacity included an additional vinyl chloride monomer plant of 70,000 tons per annum, due to go on stream in 1973, and a polypropylene plant, due to start operation in 1974. The plastics industry was experiencing a growth rate of about 15 per cent per annum, but it was faced with such problems as high production costs, arising from low-capacity operations and a relatively low internal consumption of

plastics by comparison with that in the developed countries. This situation had caused the industry to continually seek overseas markets of sufficient magnitude to offset low internal consumption, and to utilize foreign technologies pending the acquisition of the necessary experience.

Nicaragua

Industrial growth in Nicaragua had been stimulated by tax and customs concessions, and the country had profited in addition by membership in the CACM. A 10,000 tons-per-annum PVC plant supplied the CACM; domestic consumption was in the order of 225 tons per annum. Consumption of other major thermoplastics was 1,600 tons per annum of low-density polyethylene, mainly for blown film, 720 tons per annum of polypropylene, largely for woven sacks made from extruded filaments. About 100 tons per annum of other plastics were also consumed. Major problems of the industry included intensive competition from neighbouring countries, the lack of mould-making facilities, and the relatively high cost of imported primary raw materials.

Paraguay

The installed capacity for the fabrication of thermoplastics was 1,00 tons per month; actual utilization of this capacity fluctuated between 25 and 60 per cent, averaging about 33 per cent. Fabrication, which included blown-film extrusion, pipe extrusion, foam production and sign manufacture, was divided up among 15 manufacturers employing about 500 persons. Per capita consumption of plastics was relatively high in comparison with other Latin American countries. It had been 8.5 kilograms in 1971, and it was predicted to increase to 42 kilograms by 1980, which, allowing for population increase, would represent an apparent net consumption of 80,000 tons per annum. It was thought that UNIDO assistance could be used to increase the efficiency of plastics conversion in improving the standards of upper and middle management.

Paraguay

Current per capita consumption per annum was only 1.2 kilograms, and the future development of plastics fabrication in Paraguay was expected to be on a relatively moderate scale. Its rate of growth in the next

five years would depend on a number of factors, including the extent of UNIDO assistance, particularly in training operatives and in helping to solve technico-economic problems. Revised tax, financial and customs legislation under consideration were also expected to encourage manufacture.

Peru

With the exception of relatively minor quantities produced locally of PVC, polyvinyl acetate, aminoplasts, alkyds and unsaturated polyesters and polyurethanes, the plastics fabrication industry was largely based on imported materials. Per capita consumption had grown from 2.2 kilograms in 1968 to 3.8 kilograms in 1971, when apparent consumption was:

Thermosets 6,759 tons (39 per cent locally manufactured,
61 per cent imported)

Thermoplastics:

Polyethylenes	14,500	
Polypropylene	2,250	
PVC	9,140	(78.6 per cent locally manufactured)
Polyvinyl acetate	3,156	(98.9 per cent locally manufactured)
Polystyrene	3,600	
Acrylics	630	
Polyamides	5,150	
Cellulosics	1,500	

Sub-total 39,926

Total 46,685 tons

Production of polyethylene was planned as an integral part of a petrochemical complex, which was expected to have a capacity of 22,000 tons per annum and was due on stream in 1976.

Trinidad and Tobago

The plastics industry of Trinidad and Tobago was expanding. The per capita consumption of plastics had grown from 2.6 kilograms in 1966 to 7.6 kilograms in 1971, despite the small number of the population. So far, however, the industry was confined mainly to the fabrication of thermoplastics, surface coatings and adhesives. A recent UNIDO survey had indicated the advisability of conducting feasibility studies for the manufacture of selected thermosetting resins, laminates and acrylic sheet.

Although the country had well-established oil-refinery facilities and a petrochemical complex, the manufacture of monomers and general thermoplastic polymers was not anticipated for the immediate future.

Uruguay

The consumption of plastic materials in Uruguay had nearly doubled between 1967 and 1970. Per capita consumption was 3.72 kilograms in 1971, and facilities existed for the manufacture of thermosetting resins, polymethylmethacrylate and polyvinyl-acetate emulsions, together with PVC compounding. Consumption of primary plastic materials in 1971 had been in the order of 14,500 tons, comprising 95.4 per cent thermoplastics and 4.6 per cent thermosets. Future prospects were dependent on such factors as the expansion of the consumer market and a higher degree of integration with the markets of Argentina, Brazil and Paraguay. Government policy had been to intensify industrialization, particularly with respect to such industries as plastics. Agriculture was also being intensified, which might increase the demand for certain plastic items. Uruguay's development could be facilitated by international organizations, including UNIDO, as well as regional and subregional organizations.

Venezuela

The plastics industry of Venezuela operated under the aegis of the Association of the Venezuelan Plastics Industry (AVEPLA) and comprised 195 companies varying in size from less than 10 employees to more than 200; 63 per cent of the factories employed between 11 and 50 persons. In 1970, the country consumed 64,319 tons of primary materials. It was estimated that the consumption of primary materials would increase to about 144,000 tons by 1975. Major increases in the consumption of particular raw materials were expected to occur: for PVC (40,000 tons in 1972 to 67,000 tons in 1975), polyolefins (27,500 tons in 1972 to 49,000 tons in 1975), styrene polymers (10,500 tons in 1972 to 19,000 tons in 1975), and polymethylmethacrylate (1,200 tons in 1972 to 2,300 tons in 1975). Per capita consumption, which had been 5.8 kilograms in 1970, was expected to reach 7.9 kilograms in 1972 and approximately 10 kilograms by 1975.

IV. MATERIALS

Six papers were presented to the Symposium on plastic materials.

A review was given in the papers of the most significant developments that have contributed to upgrading and diversifying the properties of the well-established basic polymers in order to expand their potential applications. Particular attention was paid to the possibilities of molecular configuration and modifications in weight distribution, primary and ionic cross-linking during the forming operation, polymer alloys and blends, and the incorporation of reinforcing fillers, including acicular titanates. Special interest was expressed in the use of polymer blends, such as PVC-ABS, in the manufacture of automobile dash-panels. Up to that date, such blends had been employed in furniture construction, the PVC being based on suspension and emulsion polymers.

Two papers dealt with higher-performance polymers. The properties of the so-called engineering thermoplastics: nylon, acetals, polycarbonate, polyphenylene oxide, polysulphone and polybutylene terephthalate were reviewed. It was demonstrated that, by utilizing specific properties in order to minimize weight while maintaining adequate durability, the use of such thermoplastics in preference to certain metals and alloys, and conventional thermosetting plastics, could be justified on economic grounds. Guidelines were established for selecting the appropriate polymer in accordance with the design features of the articles for which it was intended. A detailed description was provided of the main properties of polysulphone, based on the reaction of bisphenol ⁹A⁹ with 4,4⁰-dichlorodibenzylsulphone. Its major applications as an engineering thermoplastic were enumerated from its commercial inception in 1965.

Among these polymers, the greatest interest was expressed in the acetal co-polymers, particularly in the manufacture of aerosol containers and valves. In this respect it was stated that earlier design problems in valve manufacture had been overcome and that significant inroads had been made in the use of metals, particularly for the manufacture of containers of less than three-oz capacity in the United States of America.

In a paper on the use of low-density polyethylene film in agriculture, an account was given of experiments with the synergistic effects of combinations of certain proprietary ultra-violet (UV) absorbers and free-radical absorbers in order to make low-density polyethylene resistant to the climatic conditions prevailing in Romania. Discussion of this paper centred largely on the possibility of making accurate comparisons between different geographical locations and environments, and on the reliability of accelerated testing. It was pointed out that in the case of PVC in the United States, experience accumulated over a period of 17 years, under conditions of widely varying climates and atmospheres, had provided the basis of statutory specifications.

In a paper on the manufacture of low-density polyethylene, comparisons were made of the relative merits of autoclave versus tubular polymerization techniques. It was stressed that recent developments in the autoclave process had resulted in improvements in efficiency of the product while retaining its versatility, with respect to the grade of polymer produced in terms of its density and melt index. The participants considered that the smallest economic unit was one of 22,000 tons-per-annum capacity, costing approximately \$6 million. Whether agricultural film produced from this type of low-density polyethylene had a greater inherent durability or not remained uncertain.

The market for glass fibre-reinforced polyesters was reviewed with particular reference to its potential in Latin America. High growth rates were predicted for the 1970s not only because such polyesters had gained acceptance but also because their technology had been perfected to the point where they could compete with traditional materials on a cost/performance basis. In considering the still untapped market for glass fibre-reinforced plastics in Latin America, the question of the smallest possible unit for glass-fibre production was posed. It was stated that although a plant based on four bushings could possibly be viable, one based on ten bushings would be preferred by the parent manufacturer. Such a plant would cost approximately \$1 million. The glass-reinforced plastics (GRP) applications included the production of pipe, corrugated roofing, finishing vessel, automotive cabs and bodies and house construction. (The last item is considered in chapter VI.)

The disposal of plastics waste was the main topic for consideration in the panel discussion at the conclusion of the section on materials. Contributors emphasized the problems associated with reconciling industrialization with maintaining an acceptable ecological environment, and, in general, it was agreed that plastics were currently regarded as the culprit.

The aspects emphasized were:

(a) The apparent dichotomy in the two approaches of adding stabilizers to polymers and developing polymers of improved durability on the one hand, and, on the other hand, of adding agents that accelerated the degradation;

(b) The importance of differentiating between plastics waste and plastics litter;

(c) If agents to promote bio- and/or UV degradation were added to packaging film etc., it would be essential to control stock movements to avoid the risk of premature degradation;

(d) Current developments in techniques of incineration indicated that the disposal problem could be contained;

(e) Methods for recovering, cleaning and re-using plastics waste were being employed in North America.

The need to pay greater attention to the selection of correct materials for specific applications was emphasized by a number of participants.

V. FABRICATION PROCESSES

Sixteen papers were presented on various aspects of fabrication processes. The main topics covered included: extrusion; film formation, orientation and fibrillation; injection, blow and rotational moulding; techniques for producing thermoplastic foam; glass-reinforced polyester fabrication, and developments in the manufacture of wire enamels.

Two papers dealt with twin-screw extrusion. In one the development of a proprietary range of extruders was traced and the advantages of the twin-screw principle was examined in combining compounding and extrusion in a single operation. Design features employed in overcoming such difficulties as back-pressure absorption and the attainment of optimal output capacity while minimizing the risk of degradation during plasticization were explained. The paper also treated such aspects as investment costs versus capacity utilization for unplasticized PVC pipe and profile extrusion. The second paper contained a proposal for the employment of extrusion lines for producing unplasticized PVC pipes, in sizes ranging from 50 to 200 mm nominal diameters, based on the use of twin-screw extruders of two different capacity ranges. Plant lay-out, processing, comprehensive equipment requirements, price schedules and commercial factors were described. Cost calculations, labour and energy requirements were given, and the financing needed to cover plant lay-out and technical training.

The discussion centred largely on the relative merits of rigid PVC pipe in comparison with high-density polyethylene. It was stressed that the former had superior hoop-stress ratings, but, owing to its tendency to embrittle at low temperatures, it was less popular in colder countries.

A further advantage of PVC was its suitability for domestic applications. In the dry-blending of PVC, it was possible to recycle scrap.

In a paper on developments in blown-film extrusion, the use of high-compression ratios in the transition zone, in order to maximize internal heat, was described as embodied in a step-screw principle. The operation of such an extruder was compared with that of a conventional three-stage extruder with respect to energy requirements, melt homogeneity and output. Particular features of the extruder design were discussed and a specially designed cooling-ring for achieving optimal speed and blowing directions was described for a variety of polymers. Extrusion lines for the production of biaxially oriented, shrinkable film and paper-like film, from high-density polyethylene, were also described. Lay-flat film of up to 6.40 m in width could be produced with the same equipment.

The essential features of biaxially oriented, heat-shrinkable film produced from low-density polyethylene were reviewed in the light of shrinkability versus degree of orientation, and comparisons were made with PVC film. Because of its combination of favourable properties with optimal economics, its applications were being rapidly expanded. Heat-shrinkable film of maximum clarity was obtained by the use of polyethylene of minimum density coupled with a broad distribution of molecular weight.

In a paper describing the properties, applications and manufacture of monoxially oriented, flat tapes and yarns from polypropylene and high-density polyethylene, particular attention was paid to the control of fibrillation properties by arrested-shrinkage techniques. The properties of flat tapes manufactured by both the cast and tubular film processes were assessed, particularly as compared with the properties and economics of jute and

analysis mono-filament yarns. Sales potentials were also considered, using the potential replacement of jute sacks as a guideline. It was stated that propylene co-polymers could also be used in the manufacture of tapes.

In a paper on mould design and mould making, the development of mould design was traced and the vital factors in the design of modern sophisticated moulds were considered, with emphasis on the need for complete co-ordination between the injection machine and the mould. The lay-out of a mould-making shop was dealt with, and suggestions were made as to suitable lay-outs for mould manufacture in Latin America.

Injection-moulding techniques were exemplified in a paper on two-colour injection moulding, which related developments leading to the inception of a patented, fully automatic machine for moulding artefacts in two colours. The machine described had two independently operable injection units and embodied a three-stage moulding operation, using moulds mounted on reciprocating base plates. Its application in producing either artefacts in two colours or separate, multi-coloured articles on the same machine was illustrated by slides. Various types of control from conventional relays to digital electronics were explained.

The manufacture of artefacts from structural thermoplastic foam was dealt with in two papers. The first gave particular emphasis to such factors as the injection-moulding technique, selection of mould materials and equipment manufacturers. It contained a forecast of consumption in Europe and the United States as approximately 1 million tons per annum by 1980. The second paper contained a review of the three, currently employed methods of manufacture, based on:

(a) The use of thermoplastic granules and the separate addition of foaming agent and adhesion promoter;

- (b) Pre-compounded granules ready for use by the fabricator;
- (c) The use of foaming master-batches.

A manifold runner-system made it possible for several independent moulds to be operated simultaneously.

A process for the manufacture of foamed polystyrene boards was described. It was based on the consolidation of expandable beads within a continuously moving tunnel, consisting of perforated and solid stainless steel belts and embodying heating and cooling sections. The economics and other requirements of the process were discussed on the premise that boards would be used within a thickness range of 20 to 120 mm.

In a paper on blow-moulding it was predicted that its consumption of plastics, on a world basis, would triple over the next 10 years to about 4.5 million tons. A review was made of the development of blow-moulding, current processes and equipment types, and the range of suitable polymers and their actual and potential applications were discussed. The method was considered to be as economic as other fabrication processes. Doubts were expressed as to the feasibility of introducing the use of a returnable polyethylene milk bottle in Latin America.

A description was given of rotational moulding, in fabricating hollow articles of up to 10,000-litres capacity, from plastics in the form of powder, paste and, in the case of caprolactam, in nematic forms. The process was based on the use of single- and double-walled, biaxially rotating moulds. Recent developments included its application in the manufacture of structural foam articles. The physical properties of rotationally moulded articles were felt to be superior to those of similar products made by conventional moulding techniques.

A process for molding thermosets was described in a paper on the use of automation in the spray-up process for glass fibre-reinforced polyester resins. Existing spray-up systems were reviewed, and a new method was detailed for rotational spray-casting, whose advantages in the fabrication of cylindrical articles included the possibilities of using selected proportions of continuous reinforcement. The development of techniques of this nature was considered to be significant in improving the status of the glass-reinforced plastics industry.

A review of current developments in the production of insulating varnishes included a description of the modification of polyester-based polyurethane varnishes, used in mass production, to make them suitable for direct tinning. The high thermal requirements in armature windings were being increasingly satisfied by the employment of a variety of the more highly aromatic polymers. The use of multi-coat enamelling, to afford a wider variety of properties than previously, was described.

The potential application of computers to processes for the fabrication of plastics was considered. Basic definitions and computer languages were outlined, and suggestions were made for their optimal utilization.

Current practices in the Union of Soviet Socialist Republics were referred to in the description of a methodological approach to estimating the capital investment required for the major plastic fabrication processes, including compression, injection, and rotational moulding and extrusion. The application of the approach to production and market distribution was considered.

Many of the issues debated during this session on materials formed the bases for recommendations that are incorporated in the "conclusions and recommendations".

Spare parts. The difficulties encountered in obtaining rapid and effective spare-parts service, while they varied from country to country, were considered to be generally acute. It was felt that equipment manufacturers could improve the range of critical items stocked, and that UNIDO might be of help in this respect.

Import duties on spare parts varied considerably and were low in some countries. It was suggested that these countries might serve as channels for spare parts. The need for subregional co-operation in the supply of parts was emphasized.

Mould supplies. Investment in moulds was frequently found to be abnormally high in relation to the size of markets. Although attempts to institute rental and leasing systems for moulds had met with great difficulties, it was clearly felt that efforts in this direction should continue. It was reported that a firm in Denmark was operating a rental system for moulds.

Other problems. Each country faced its individual problems, usually associated with market size, educational and training facilities and consumption patterns. (Where possible, recommendations covering common problems have been included in this report.) It was felt that emphasis on such factors as subregional integration, a free exchange of technological information and greater attention to the efficiency rating of fabrication equipment would help substantially in solving these problems.

VI. APPLICATIONS

Eleven papers dealt with the various applications of plastics. Of particular significance were three papers and a panel discussion on the use of plastics in housing, (since proposals were being considered for the manufacture of low-cost housing from plastics on a regional basis by mass-production techniques to relieve housing shortages in developing countries).

The use of plastics in packaging was treated in reference to the manufacture and application of PVC bottles, the manufacture and application of paper-like film from high-density polyethylene, the manufacture of injection-moulded crates for transport use, and the current development of high-barrier film for packaging oxygen-sensitive foodstuffs and carbonated beverages.

In the introductory paper trends and developments in France were cited as analogous to the situation and potential in Latin America; the penetration of markets and the growth in demand for PVC bottles in such specific sectors as edible oils, wine, natural mineral waters, vinegar, pharmaceuticals and cosmetics were also treated. The extrusion blow-moulding process was described, and the most important criteria were given for its use. Recently developed bulk-polymerized PVC had been found to be capable of overcoming initial defects in clarity and leachable constituents, and it was being applied increasingly.

In the course of the discussion concern was expressed over such matters as the migration of ester-based aromatic and flavour constituents into the PVC, lack of compliance with food laws in various countries, and problems of sterilization.

As plants for the production of paper-like film from high-density polyethylene had come on stream only comparatively recently, it was considered too early to estimate market potentials. Nevertheless, since the qualities of film available were improved and the difficulties of downstream-processing, particularly with respect to welding, printability and laminating, had been largely overcome, a wide range of applications of such film to packaging was foreseen. A comprehensive account was also given of the development, manufacture and properties of thin paper-like film from high- and low-density polyethylene.

In a review of the manufacture of crates, mainly from high-density polyethylene, for the transport of bottles and other products, it was pointed out that the requirements and properties were similar to those for the manufacture of certain items of furniture from such materials as ABS and polypropylene.

The use of a wide range of plastics in the manufacture of furniture was reviewed. Taking the Federal Republic of Germany as a guide to potential demand, a twelvefold increase in consumption was predicted by 1980 over 1968. In this context, the growth of plastics was said to be affecting significantly trends in design. In weighing the pros and cons of furniture manufacturers' fabricating their own plastics, it was emphasized that co-operation with plastic fabricators was becoming increasingly important. Discussion centred on the relative differences between the developing countries, with their comparatively abundant timber sources and low labour costs, and the industrialized countries where resources were depleted and the cost of labour was high. Although such countries as Brazil and Argentina had been producing and exporting furniture embodying, for

example, both wood and PVC, furniture made entirely of plastic had been produced on an appreciable scale only in the industrialized countries.

Three papers dealt with the application of plastics to agriculture. A review was given of world trends, with particular reference to Latin America, and two irrigation projects in Romania were described. A recent development reported was the use of expanded polyethylene in the cultivation of mushrooms. Reference was made to the FAO-Industry Co-operative Programme (ICP), and participants engaged in the field of agriculture were urged to make maximum use of the consulting services of FAO which were available in Latin America.

With reference to applications of cellular plastics to agriculture, particularly as soil conditioners, it was stated that the incorporation of cellular urea-formaldehyde resins into the top soils of arid and semi-arid regions to promote water retention and aeration, as possible alternatives to composts, could increase world food production. Experiments carried out in Saudi Arabia during 1962/1963 had shown promise in this respect. The potential applications for other plastic foams in agriculture were enumerated and included the possibility of using foamed polystyrene flakes to loosen and aerate compacted and water-logged clay soils.

The United States of America was indicated as an example of world potential in the development of plastic lighting equipment. The consumption of polystyrene and polymethylmethacrylate in the United States nearly doubled between 1965 and 1971. Among the more recently developed plastics, polycarbonate was increasingly used, particularly in the fabrication of diffusers more resistant to heat and chemicals. It was agreed during the discussion that comparisons between the lighting standards of various countries were difficult to make. It was pointed out that although

polycarbonate had a superior temperature performance to polystyrene, but it was inferior with respect to resistance to yellowing; consequently, methacrylate polymers of improved heat resistance were being explored.

In the first paper dealing with the application of plastics to housing, 20 types of houses built with plastic materials were described and illustrated. A second paper, presented on behalf of the joint UNIDO-Romania Centre, described the stages involved in a programme for the mass-production of houses to be undertaken with multi-national co-operation. A third paper, devoted to the Welz system of applying plastics to housing construction, contained a proposal for a special, modularly designed structure, based on GRP laminate foamed-plastic sandwiches, capable of being folded for transport and unfolded on site. The system was intended for low-cost housing schemes in the developing countries.

In the panel discussion, specifically related to the use of plastics in housing, it was indicated that prototypes of the housing units embodied in the Welz system were expected to be ready within six to eight months.

While the urgent need for mass-produced, low-cost housing was generally recognized and the Welz system was regarded as an ingenious and logically conceived approach, some participants had misgivings that certain of the construction materials were not sufficiently durable. Its proponents claimed, however, that the durability of the materials had been attested to by a number of large, reputable manufacturers. From the social point of view, it was felt by some that modular construction might find limited acceptability. It was recognized that most of these questions could be solved only in terms of step-wise trials and that, although the final answer to the construction of mass-produced houses might not be houses made entirely of plastic, a considerable proportion of plastic materials were certain to be employed.

VII. TRAINING AND TECHNICAL ASSISTANCE

Three technical papers concerned centres and training institutes for plastics technology, and one paper contained a description of the UNIDO technical assistance programme.

In a paper describing a model plastics technology centre, comprehensive coverage was given the various aspects and functions, including staffing, equipping, investment and operating costs. The centre, which would be responsible to a governing council and guided by a panel of consultants, would have as its objectives:

- (a) To provide a technical and advisory service to manufacturers and others;
- (b) To improve liaison between Government and industry;
- (c) To improve liaison between educational establishments and industry;
- (d) To support other agencies in such matters as standardisation and quality-control surveillance, while not at the same time duplicating the functions of those agencies.

Its functions would be divided among a basic section for fabrication technology, materials testing and evaluation, and engineering application and design; a scientific section covering chemistry, physics, economics and marketing; and a statistics and information service.

Additional activities would include organising fellowships and operating training programmes and seminars. The establishment of such an institute on the scale described would be likely to entail a total investment cost of \$2,530,000, an initial operating budget of \$399,400, and a developed budget of \$588,400. Methods of financing by, for example, funding and industrial contribution were considered.

The second paper described the structure, operation and functions of the Laboratory for Plastics Technology (LKT), Vienna, and suggested that it could serve as a convenient model for South-Eastern Europe.

LKT demonstrated how the various activities of secondary education, training, testing, research and development may be co-ordinated in a matrix organization to form a complex unit of high efficiency in the field of plastics technology. It combined an institute for higher technological education, a post secondary college for plastics technology and a federal testing station for chemicals and plastics. It also established courses and seminars related to training and vocational training and served as a research institute for trade and industry within the framework of the Association for the Promotion of Plastics Technology, a private organization supported by 180 member firms. LKT had a full-time staff of 70 and more than 400 students and vocational trainees; it operated on an annual budget of 20 million Austrian Schillings.

In the discussion of the plastic technology centres, interest was expressed in equipment cost, personnel training, management, and the time necessary to become self-supporting. With respect to equipment, it was stressed that costs had been quoted at the lowest possible levels. The suggestion was made to utilise reconstructed fabrication machinery with minimum accessories rather than sophisticated units with expensive accessories. One case was cited where equipment had been transferred from a production unit to a training centre.

In view of the obvious lack of experienced personnel to man the various sections in a model technology centre, it was suggested that UNIDO might arrange short-term assignments of qualified experts from developed countries. As a means of training personnel, it was suggested that short-term assignments

of experts from local industry or from outside to the centre should be considered, such as the assignment of an experienced engineer from the private sector to undertake a programme to familiarize trainees with a new type of processing equipment. Long-term assignments would be especially applicable to market analyses and cost estimating. It was emphasized that the programme at LKT provided both training and field experience.

The concluding paper described UNIDO technical assistance in terms of basic aims, advice to developing countries, initiating and maintaining contacts and sponsoring training programmes.

As an introduction to the discussion, a description was given of how private sectors and institutions could approach UNIDO for assistance and services. Particular emphasis was accorded to management assistance. Such questions as break-even points in productivity versus earnings, standard costs, management of inventory and procurement of efficient technical equipment aroused considerable interest among the participants. It was emphasized that UNIDO had been maintaining close contacts with industry and had been able to provide services beyond management, including the installation of pilot plants when requested by a specific country. The role of institutions, such as ACOPLASTICOS, in the UNIDO programme was emphasized, because of the local effort involved in organizing such symposia. The Symposium was considered to have exemplified a fruitful way in which private sectors could co-operate to enlarge investment opportunities.

VIII. INVESTMENT PROMOTION

Investment-promotion activities were organized as a supplementary programme at the Symposium, in order to stimulate investment opportunities in the plastics industry, to plan individual projects, to establish and operate industrial enterprises on a larger scale, to apply new technologies, to identify the interest for joint business ventures, and to obtain the necessary financing.

The Symposium offered an excellent opportunity for the participants to combine techno-economical project studies with an analysis of the financial implications of promoting a project. The investment-promotion activities consisted of a series of actions to ascertain conditions for feasibility of investments in addition to the techno-economic feasibility of the project itself. Representatives of the UNIDO secretariat also encouraged direct contacts between the participants, experts, government officials, businessmen and observers from international organizations.

Going to the wide range of interests among the participants, promotional activities went beyond the discussions of investments in equity or loans. Business relationships were established that may lead to contractual arrangements, such as joint ventures, licensing agreements, subcontracting for the production of plastic appliances, co-operative arrangements, and leasing for equipment. Many requests were received on obtaining financial and technical resources from foreign partners, on the exchange of banking information, and on help in establishing appropriate forms of co-operation of mutual interest.

The role of UNIDO in investment promotion was merely to identify the interested parties and to organize meetings between them. About 80 confidential business talks were pre-arranged for participants, many of them

leading to actual investments in the plastics industry in Latin American countries. A greater number of private business meetings were arranged after this initial phase.

Ten industrial projects for the plastics manufacturing industries in Latin America were worked out in detail for promotion either at the meeting or for follow-up at UNIDO headquarters in Vienna. UNIDO would continue to help to present commercially attractive projects, to locate potential partners and to initiate further contacts among them.

Participants from industrialized countries described their fields of business and the terms and conditions for co-operation. Thus, participants learned from potential investors themselves the essential ingredients for successful investment promotion.

Annex

PAPERS PRESENTED TO THE SYMPOSIUM

ID/WG.137/1	Programme
ID/WG.137/2/Rev.2	List of documents
ID/WG.137/3/Rev.3	List of participants
ID/WG.137/4 and Summary	Development and prospects in manufacturing methods for low-density polyethylene P. Durand, France
ID/WG.137/5 and Summary	Polysulfone - Seven years in the market-place F. W. Wurtzell, United States of America
ID/WG.137/6 and Summary	Recent developments in the manufacture of wire enamel for magnet wires in electronic and motor applications H. Schlegel, Federal Republic of Germany
ID/WG.137/7 and Summary	Food-grade PVC bottles manufacturing in France - Use of bulk PVC L. Goiran, France
ID/WG.137/8 and Summary	Subregional integration in plastics processing A. Hahn, France
ID/WG.137/9 and Summary	Value engineering with engineering thermoplastics R. J. Kakon, United States of America
ID/WG.137/10 and Summary	Blow moulding L. G. Phillips, United States of America
ID/WG.137/11 and Summary	Two-colour injection moulding A. Eigner, Austria
ID/WG.137/12 and Summary	The manufacture of nonoxially stretched film tapes H. Buntinghaus, O. Heine, Wolfgang Hofmann, Federal Republic of Germany
ID/WG.137/13 and Summary	Paper-like film from high-density polyethylene J. H. Grunze and P. J. Ehler, Federal Republic of Germany
ID/WG.137/14 and Summary	Plastics add a new dimension to furniture H. Schloede, Federal Republic of Germany
ID/WG.137/15 and Summary	A model plastics technology centre for developing countries J. P. Lantz, United States of America
ID/WG.137/16 and Summary	Opportunities for glass-fibre reinforced plastics in developing countries R. G. Lantz, United States of America

- ID/WG.137/17
and Summary
Testing methods for investment requirements and estimates in fabrication of plastics
J. F. Lontz, United States of America
- ID/WG.137/18
and Summary
Advances in plastics polymers and resins for improved and expanded applications
J. F. Lontz, United States of America
- ID/WG.137/19
and Summary
The use of cellular plastics for the improvement of soil structure (PLASTOPONICS)
H. Baumann, Federal Republic of Germany
- ID/WG.137/20
Present status and future plans of the plastics industry in Brazil
J. M. de Oliveira Ramos, Brazil
- ID/WG.137/21
Situación actual y planes para el futuro de la industria de los plásticos en Costa Rica
R. Lopez Agüero, Costa Rica
- ID/WG.137/22
Situación actual y planes para el futuro de la industria de los plásticos en la República Dominicana
R. D. Mejía García, Dominican Republic
- ID/WG.137/23
Present status and future plans of the plastics industry in Guyana
A. K. N. Hamid, Guyana
- ID/WG.137/24
Situación actual y planes para el futuro de la industria de los plásticos en Panamá
O. Carlos S., Panama
- ID/WG.137/25
Situación actual y planes para el futuro de la industria de los plásticos en el Perú
H. Salinas Ruiz-González, Peru
- ID/WG.137/26
Present status and future plans of the plastics industry in Trinidad and Tobago
G. N. Voss, Trinidad and Tobago
- ID/WG.137/27
and Summary
Structural foams from thermoplastics
K. F. Grafe, Federal Republic of Germany
- ID/WG.137/28
and Summary
Polyethylene heat-shrinkable film
G. A. Sandino Salcedo, Colombia
- ID/WG.137/29
Situación actual y planes para el futuro de la industria de los plásticos en el Salvador
R. Zucoto, El Salvador
- ID/WG.137/30
Situación actual y planes para el futuro de la industria de los plásticos en Colombia
F. Barragán, A. Frelich, G. Sandino, J. H. Tamego, H. Mora, Colombia
- ID/WG.137/31
and Summary
Rotational moulding
A. F. Böhmman, Federal Republic of Germany
- ID/WG.137/32
Situación actual y planes para el futuro de la industria de los plásticos en el Uruguay
P. Invernizzi, Uruguay

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and Summary

Developments in blown-film extrusion
J. Müller, Federal Republic of Germany

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Situación actual y planes para el futuro de la
industria de los plásticos en Guatemala
C. A. Argueta Arbiau, Guatemala

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and Summary

Mould design and making
P. Ernst (Summary by K. F. Grafe),
Federal Republic of Germany

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and Summary

Continuous moulding of polystyrene board
J. Zembron, Sweden

ID/WG.137/37
and Summary

Trends in the development of plastics lighting
equipment
M. Glass, United States of America

ID/WG.137/38
and Summary

The production of pressure pipes from rigid PVC
V. J. Andres, Switzerland

ID/WG.137/39
and Summary

Contribución de la organización de los estados
Americanos al desarrollo de la industria de
plásticos en America Latina
E. Sucké, United States of America

ID/WG.137/40
and Summary

Las materias plásticas en America Latina
IILA (Summary by H. P. Yano, Chile)

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Situación actual y planes para el futuro de la
industria de los plásticos en Nicaragua
F. Sobole, Nicaragua

ID/WG.137/42

Situación actual y planes para el futuro de la
industria de los plásticos en el Grupo Andino
C. A. Gary Salasano, Peru

ID/WG.137/43
and Summary

International views of fibreglass houses
H. Sura, Colombia

ID/WG.137/44
and Summary

Current trends in plastics
UNEP, Austria

ID/WG.137/45
and Summary

Cajas de transporte y auxiliarie
C. Salama Liebzig, Spain

ID/WG.137/46
and Summary

Climatic protection of polyethylene film
V. Janita, Rumania

ID/WG.137/47

Situación actual y planes para el futuro de la
industria de los plásticos en Venezuela
G. Hernandez Perea, Venezuela


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and Summary

Laboratorium für Kunststofftechnik - IKT - a possible
model for institutes of training, testing and research
in plastics
H. Schmitt and H. Raboy, Austria

ID/WG.137/49
and Summary

Automation in the spray-up process for fibre-glass
reinforced polyester resins
J. Gudenhave-Kalergi, Austria

- ID/WG.137/50 Leasing - a method to combine financing and management responsibility
A. Schwab, Switzerland
- ID/WG.137/51 The application of computers to the plastics industry
A. Schwab, Switzerland
- ID/WG.137/52 Introduction to UNIDO technical assistance programme
not yet issued UNIDO, Austria
- ID/WG.137/53 Introduction to UNIDO investment-promotion assistance
and Summary UNIDO, Austria
- ID/WG.137/54 Twin-screw extruders
and Summary F. Burger, Federal Republic of Germany
- ID/WG.137/56 Situación actual y planes para el futuro de la industria de los plásticos en Honduras
A. Bennaton Pineda, Honduras
- ID/WG.137/57 Espumas estructurales termoplásticas
and Summary Mariano Sanchez, Colombia
- ID/WG.137/58 Situación actual y planes para el futuro de la industria de los plásticos en el Ecuador
A. B. Rodriguez Zambrano, Ecuador
- ID/WG.137/59 Situación actual y planes para el futuro de la industria de los plásticos en Chile
N. Abarca Alfaro and P. Sabagliati C., Chile
- ID/WG.137/60 Situación actual y planes para el futuro de la industria de los plásticos en Paraguay
T. B. Cataldo Figueri, Paraguay
- ID/WG.137/61 Situación actual y planes para el futuro de la industria de los plásticos en Bolivia
P. Illanes de la Haza, Bolivia
- ID/WG.137/62 Estimate of capital investment for main stages of plastic processing - Methodical approach
and Add.1 B. V. Sestov, Union of Soviet Socialist Republics
- ID/WG.137/63 Capacitación de operarios y Profesionales para la industria plástica. Una experiencia Argentina.
L. Riviere Bellociano, Argentina
- ID/WG.137/64 Plásticos en la agricultura panamericana mundial y proyección en América Latina
Gregoria Pizarro, Argentina
- ID/WG.137/65 Plastics technology - Materials and technology
and Summary Herman Hart, United States of America
- ID/WG.137/66 Situación actual y planes para el futuro de la industria de los plásticos en la Argentina
C. H. Nardini, Argentina
- ID/WG.137/67 Algunos aspectos de la industria petroquímica en los países de la Asociación Latino-Americana de Libre Comercio
Alfredo Behrens, Departamento Industrial de la Secretaría de la Asociación Latinoamericana de Libre Comercio

- ID/WG.137/68
Summary only
A new field of plastics application in Romania -
Irrigation of agricultural areas
V. Ionita, Romania
- ID/WG.137/69
El control como un medio de progreso en calidad
Max Roth, Switzerland
- ID/WG.137/70
Draft report
- ID/WG.137/71
New trends of using plastics materials in construction
V. Ionita, Romania
- ID/WG.137/72
Situación actual y planes para el futuro
de la industria de los plásticos en Costa Rica -
El Salvador - Guatemala - Honduras - Nicaragua
G. Argueta, A. Bennaton, B. Cuadra, R. Escoto,
R. Larion, R. Lopez, P. Robelo
- ID/WG.137/73
Industry Co-operative Programme (ICP) of FAO (Plastics
in Agriculture Working Group)
H. Ingrand, Italy
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