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United Nations Industrial Development Organization

Symposium on the Development of the Plastics Fabrication Industry in Latin America

Bogotà, Colombia, 20 November - 1 December 1972

A MODEL PLASTICS TECHNOLOGY CENTRE FOR DEVELOPING COUNTRIES 1/

by

J.F. Lontz
Private Consultant
Wilmington
Delaware, U.S.A.

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SUMMARY

A MODEL PLASTICS TECHNOLOGY CENTRE FOR DEVELOPING COUNTRIES

by

J. F. Lontz
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Wilmington, Del. USA

Plastics technology in developing countries is attaining recognition of importance to the substained growth of the plastics industry. Particularly for the developing countries, the establishment of a plastics technology centre to provide guidance and impetus to the indigenous plastics production is a vital undertaking, especially in view of the rapid technological innovation and penetration of plastics into construction industries, agriculture and myriads of consumer items. Thus, the effective utilization of plastics coupled with sound design and effective plastics technology of properly selected plastics resins, requires constant technical surveillance to ensure durable and reliable performance. Therefore, a centre accorded this technical responsibility, especially in the co-ordination of resin, fabrication, design, end uses and markets is deemed indispensible. This has been evident from several site visits by UNIDO undertaken at the request of developing countries. A Model Plastics Technology Centre has therefore been devised to provide this co-ordination with technical, operating support.

Central to the concept of the Model Centre is the Fabrication Technology Section provided with prototype equipment and facilities involved in connecting indigenous plastics resins serving national needs in major construction programs and consumer items. A manning strength consisting of technologists and operators is suggested with the implied presumption of being adjusted or augmented vis-a-vis the national needs and growth of the plastics industry.

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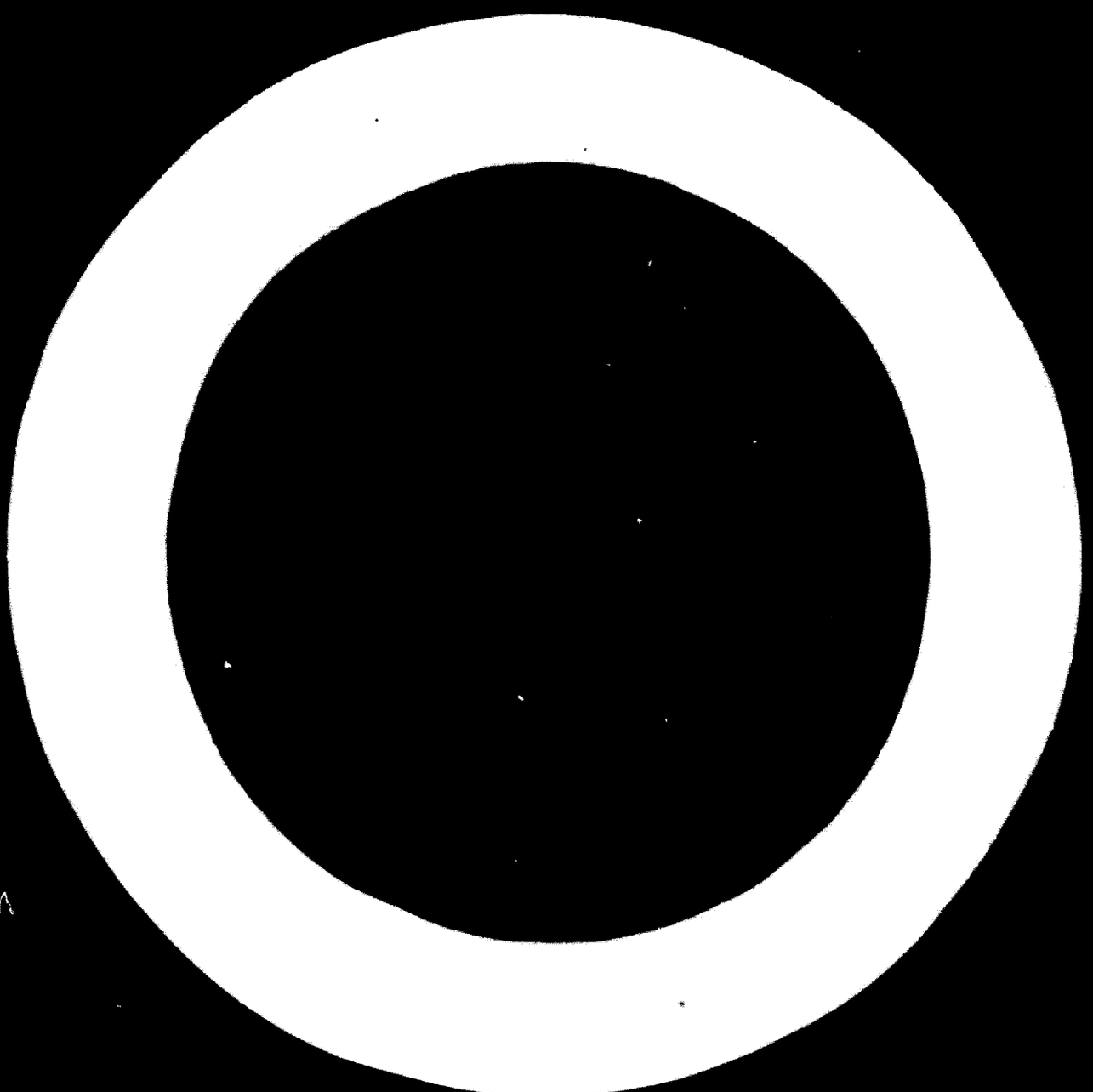
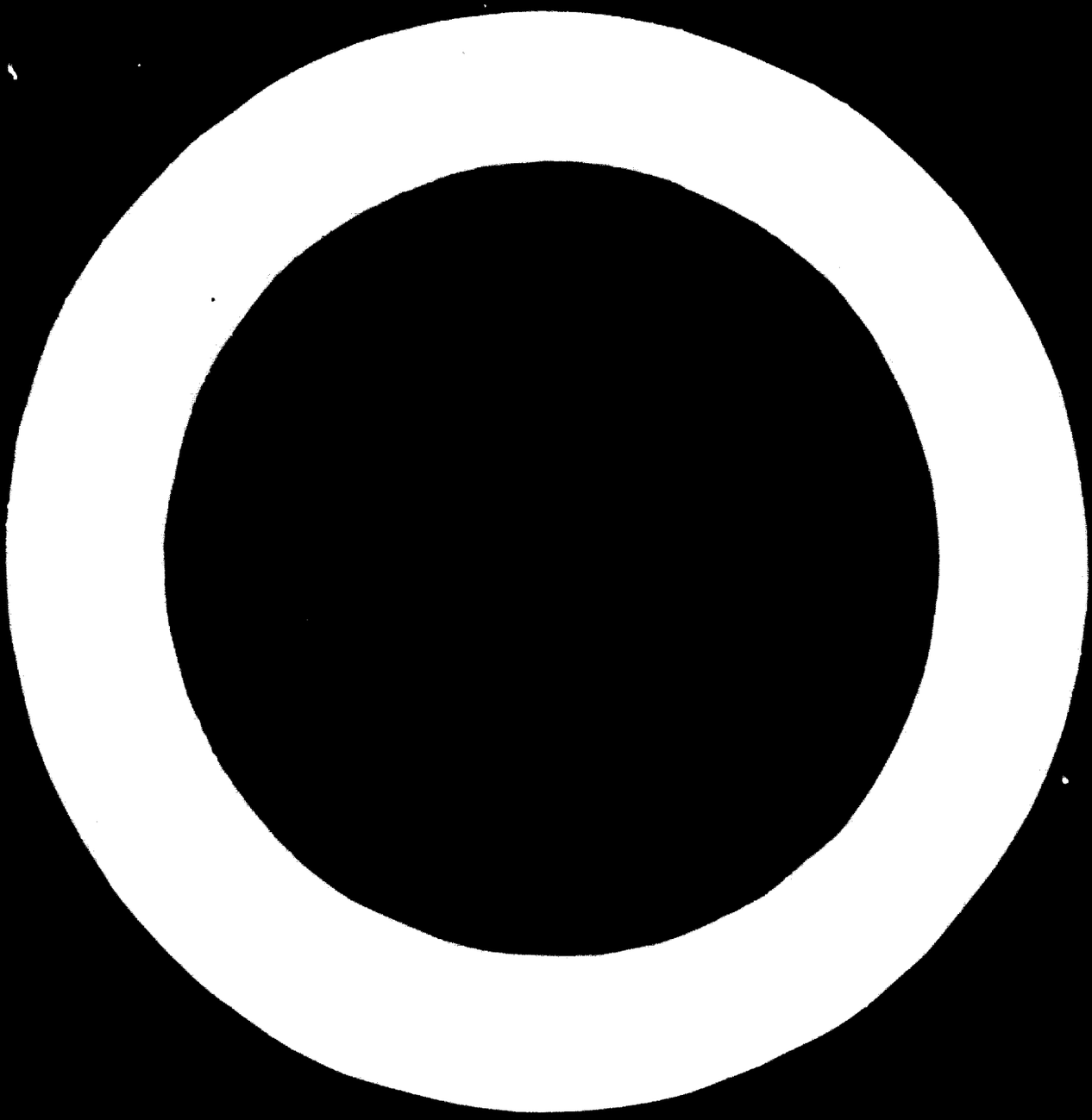


A necessary affiliation to the Fabrication Technology Section is a Materials Testing and Evaluation Section serving to provide appropriate data and quality control on resins, fabrication operations, article design and endurance.

Next, an appropriate Applications Engineering Section is structured for the important and often critical design functions. This section is intended to stimulate new uses and outlets with due regard to economic merits.

Finally, a Plastics Basic Science Section is included to ensure that the Centre has a constant source of information on the chemistry and physics of plastic polymers that too often is marked and even varied under the general proprietary codes. Additionally, this Section can serve to evaluate established plastic polymers in terms of fundamental chemical and physical characteristics, resin quality and uniformity and to maintain similar surveillance and recommendations on plastics advances emerging in other regions.

A financing mechanism is proposed for (a) the initial capital expenditure and (b) the operating budget for at least the first three years. This involves some capital funding from extra-territorial banking institutions chartered to assist developing countries, augmented by some indigenous funding. For the operating budget, a funding concept based on current plastics production with allocated research and development cost charges applied to the annual sales or transfer costs for both the total resins and fabrication volume figures is proposed. A hypothetical example with break-down of the funding involving a nominal country or regional product of a modest estimate is presented. The mechanism is set up in a manner that would instill confidence in the eventual self-sufficiency of the Centre.



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I. Introduction

1. The concept of a Plastics Technological Centre has emerged from field surveys and incidental assessment of the needs of the plastics industry in developing countries. Typical of such surveys undertaken by UNIDO missions are the reports provided on technical assistance for development of the plastics fabrication industry in Chile (UNIDO/ITD/15, 5 May 1970) and in Nicaragua (UNIDO/ITD/21, 25 June 1970) to cite illustrative examples. As in any industry, the need for materials standards, with specified test procedures to assure quality and durability, is indispensible to the maintainance of consumer acceptance and economic sustenance of the plastics industry as a whole. On this account, UNIDO has initiated projects for establishing standardization of plastics in developing countries, culminating in a monograph (Petrochemical Industry Series No.5), with details on organization, facilities and listing of standards.

2. The role of a plastics technology centre is gradually assuming specific functions, such as are detailed in the ensuing presentation. However, the tables of organization of a centre as an organized agency do not necessarily follow any uniform pattern. This is because the plastics industry has grown and matured from varied institutions and disciplines by historical growth since the advent of plastics fabrication into a competitive, viable industry.

3. A plastics technology centre will have to assume specific functions in which fabrication represents an important intermediary and link between the resin starting materials on the one hand and the end-use consumer item on the other. Moreover, the centre can fulfill the much-needed facilities, staff, and training for conducting standards test and provide performance data for product certification of a plastics resin and its fabricated component. Derived from appropriate authority and administered by competent governing council, the centre can then serve a broad spectrum of the plastics industry.

3. This report is intended to provide one concept of organization, functions, and financing of a model plastics technology centre for a country or a multinational region serving as a supporting agency. The one principle assumption is made in this concept that the fabrication industry served by the centre will have attained eventually a productive stage of growth and capacity to fulfill substantially the required national or multi-national planning for use of plastics and will enable the centre to become at least partially self-supporting. In effect, this presentation is one exercise from which adjustments, either as amendments or deletions can be made for what are obviously uniquely diverse needs for a model centre among various countries and multi-national regions.

II. Concept of a Model Plastics Technology Centre

Derivation of responsibilities

5. The establishment of a Model Plastics Technology Centre will require well-defined derivation of its organization for the purpose of regulating its responsibility to national goals on the one hand and fabrication capacity on the other. This in effect sets up the charter or raison d'etre. It then follows that owing to the diverse involvement in the plastics industry and its consequent fabrication on the part of the government, plastics trade agencies or institutes, and standards organization, the centre should have its authority and responsibilities chartered by a Governing Council drawing upon representatives of these agencies. This represents the derived authority which will prepare and review in the broad sense the missions and functions of the Centre as a guide for its directorate as indicated in Chart 1. Additionally the Governing Council owing to the liklihood of inadequate coverage of fabrication standards or the liklihood of duplicative and conflicting interests in standards of quality and performance, will in turn be the adjudicating authority for either expanding the mission of the Model Plastics Technology Centre or defining limitations of its functions as the case may be.

5.1. The Directorate in turn should have the authority to nominate and appoint various experts into a consultant panel drawn from professional material scientists, educators, industrialists and consumer institutes to counsel on plastics applications, their priorities, and required standards of performance and endurance.

Mission of the Model Plastics Technology Centre

6. The Model Plastics Technology Centre may be charged with the following missions with appropriate modifications in scope and relations with other agencies or institutions involved directly or in competition with fabricated plastics products.

6.1. The Model Plastics Technology Centre will provide technical and advising services to manufacturers, processors (converters, fabricators and finisners) and users of plastics. It is a non-executive body in all matters other than its internal management.

6.2. The Model Plastics Technology Centre will act as a bridge between the government or the consortium of supporting regional governments on the one hand and the plastics industry on the other.

6.3. The Model Plastics Technology Centre will act as a bridge between the industry, the universities and other educational and training institutions, translating the industry's need for manpower in both quality and quantity to the universities and other educational and training institutes, and advising the government and industry on future requirements of trained personnel. The Model Plastics Technology Centre will also act as a catalyst to promote close contact between industry and these educational institutes.

6.4. The Model Plastics Technology Centre will consult with other agencies involved in the design and use of plastics and will take the initiative in developing and participating in standards and their surveillance for quality for plastics products of national and extra-national origin and in doing the necessary missionary work to make these standards acceptable to all concerned.

6.5. The Model Plastics Technology Centre will contact and co-operate with similar agencies in other countries or regions and will endeavor to avoid duplication, except for confirming reasons of round-robin testing and laying down of specifications or regulations which would assist the commerce of plastics materials and articles.

Functions of the Model Plastics Technology Centre

7. In order to function primarily as a technological organization capable of carrying the above-listed missions which are largely of an extra-mural nature, the Model Plastics Technology Centre shall be vested with authority, facilities and funding to carry out the following fuctions:

7.1. The Model Plastics Technology Centre will set up three basic functions comprising fabrication technology, materials testing and end-use evaluation, and engineering applications and design. Each of these functions will be provided with appropriate manning strength,

facilities, and equipment capable of conducting prototype or pilot production of plastics articles for end-use endurance and economic merit. Professionals or technicians assigned to this section should also be trained to assume responsible management or supervision, respectively, by promotion and transfer to actual industrial installations.

7.2. The Model Plastics Technology Centre will set up a scientific section comprising the various disciplines of chemistry, physics, engineering and economics including marketing that are most germane to plastics fabrication and their intended applications. This section shall also serve as a training ground for future plant direction or higher responsibility in related or affiliated positions of responsibility in plastics industry and commerce.

7.3. The Model Plastics Technology Centre will set up and maintain a statistical and information service on plastics within the administrative section for the benefit
of its dependent member industry and trade agencies, to be available in the interest of good relations to other interested agencies within reasonable limits. This statistical and information service will also undertake publications for member industry affiliates
priate information and articles on the plastics industry in other journals. The statistical and information service can also serve as a clearing house for procuring standards procedures, materials specifications and trade literature.

7.4. The Model Plastics Technology Centre will provide short-term, up to one year, resident assignments and on-the-job training for selected individuals from its member industry affiliates in developing management or supervision experience in fabrication technology and materials testing section as a training and educational function of the Centre.

7.5. The Model Plastics Technology Centre will set up seminars on new fabrication technology, including any demonstration equipment for its member industry and converters (coating, heat sealing, lamination end-use articles) or plastics processing firms concerned.

III. Organization of the Model Plastics Technology Centre Sections

8. The organization of the Model Plastics Technology Centre as depicted in Chart 2 will comprise a Directorate with its Consultant Panel, four technical sections, and one administrative supporting section. The model is merely one of responsibility and functioning to ensure that the broadest facet of plastics technology, from fabrication to end-uses with innovations for new markets and cost-merits, can be constantly provided for, not only in the developing stage but also in its transition to a reasonably established level. The manning strength with the indicated professional and technician personnel, with the required laboratorians, equipment operators, skilled crafts and supporting administrative people can be doubled-up, so to speak, in one individual. This may be a necessity either from budget limitations or non-availability of qualified personnel.

8.1. Directorate. This shall comprise the Director and any associate directors that may requested by specific industry sections or by members of the multi-national regions. It shall be responsible to the Governing Council as suggested in Chart 1 for the execution of the missions and conduct of the functions of the Centre. The Director, as principal executive officer, will in addition maintain a Consultant Panel drawn from member fabrication industries, educational institutes, standards or normalization agencies, selected primarily on the basis of their working know-how ranging from the field of fabrication technology, including training on techniques for market studies and development. The Directorate will also have charge of the Administrative Section which will serve to support the non-technical working of the Centre. The personell manning strength as indicated in the Table 1 provides one suggested salary and wage scale rating.

8.2. Administrative Section In addition to the usual administrative and clerical support this Section will operate the statistical and information service for the Centre, headed by a manager of experience in a broad area from operational budget control to personnel management. It will also maintain responsibility over craft services and will administer the manning and functioning of a library, headed by a professional librarian with translating ability.

8.3. Fabrication Technology Section A central focus of the Centre, this Section shall include in its manning table of organization plastics engineering headed by a manager knowledgeable in areas of resin conversion and mechanical and electronic control of machinery and equipment. The manning personnel shall include plastics engineers skilled in design of molds, dies, and ancillary take-off and finishing equipment in the conventional technology of injection-molding, extrusion, calendering, transfer and composition moulding. This Section shall be further supported in necessary shop work by the above mentioned crafts sectionsupervised by a mechanical engineer competent in converting engineering designs into metal-fabricated items.

8.4. Materials Testing and Evaluation Section This Section shall be responsible for conducting all standard and non-standard physical, mechanical, electrical and environmental tests following procedures of authortative standards as well as specific industry and consumer standards. It will be headed by a manager, competent in materials science, and capable of managing such sections concerned with quality control methodology and statistical assessment of test data.

8.5. Applications Engineering and Design Section This Section shall be responsible for providing liaison of the Centre with design engineers, civil engineers, architects and other professional skills to develop new plastics articles including those needed for projects on large scale. Under the leadership of a section manager, the section will assist in all or any stages of fabricated plastics products, including installations, to include concept design, material selection, unit or part design for static and dynamic endurance and environmental exposure, economic and cost analyses, prototype mold design for cyclic efficiency and stress endurance and finally co-ordinate the preparation of specifications for materials, fabricating conditions, quality control methodology and inspection schedule. This section will be organized keeping in mind end-use orientation with specialists in construction and building, industry, appliance and automatic parts, mechanical goods, packaging articles and others.

8.6. Plastics Basic Science Section This Section headed by a Senior Scientist experienced in polymer science and technology is provided to the Centre for the express purpose of developing a professional prestige so necessary to back up the Centre in advancing the development of plastics in competition with conventional materials. This Section shall comprise one or more polymer chemists, polymer physicists, polymer engineers, supported by a statistics-mathematician and laboratory personnel for fabrication research. The Senior Scientist may also serve as Associate Director in order to provide a balance between the technology of fabrication, on the one hand, and the inherent merits of the plastics base polymer on the other. As Associate Director, the Senior Scientist shall serve as chairman of the Consultant Panel comprising outside professionals, particularly polymer scientists, largely from universities, engineering institutes, convening in regular schedules for reviewing projects and programmes. The section may also include short term, up to one year, assignment of institute graduates selected for careers in plastics fabrication technology.

8.7. The aggregate manning strength of the entire personnel for the Model Plastics Technology Centre is further summarized by professions and skills in Table 1. A further assessment of the latter is presented in Table 2 derived from survey missions carried out by UNIDO in various regions. The latter Table 2 also includes the projected volume of plastics production in the respective regions with the idea that a Model Plastics Technology Centre may be constituted in some consistent ratios of manning level to plastics production. This is simply a first round suggestion for determining just what should be the manning strength.

8.8. There may be a valid criticism against using the manning strength / production tonnage ratio without consideration of how underdeveloped a given country or region may be. The manning strength / production ratio is preferred against an alternative of manning strength / total sales because the latter imposes a greater uncertainty in the real value. Furthermore, on quality control considerations alone, which means that production volume is the real factor for reference, the former ratio is again defended.

IV. Facilities and equipment of a Model Plastics Technology Centre

Initial planning area

9. As is the case with the manning table of organization, the facilities and equipment for a Model Plastics Technology Centre will depend upon several factors or conditions. The lay-out of a building for the Centre is obviously a matter of qualitative choice of functional design. Initially, the establishment of a Centre for reasons of expediency should,and invariably could be in an available building. However, prompt planning will be important for a site and building lay-out with some proportionation of needed space such as suggested in Table 3. It is interesting to note that the initial allocations for planning purposes totally 4500 square meters compares favorably with the 4000 square meters suggested for the establishment of a laboratory for testing plastics according to Table 3 of the Plastics Industries Series Monograph No.5.

9.2. **Facilities.** In general, the facilities will require such special features as a constant temperature room (ISO R 291-1963), fume removal ducts, heavy duty power lines. The design should also provide for foundations to accomodate heavy fabrication machinery, while the laboratories should have centralized service lines for easy access and maintenance and repair. Not included are outside sheltered storage of accumulated fabricated articles for disposition. The obvious sanitation, work change rooms, etc., are implied in the several functional areas. Some special isotope isolation space may be required and hence need special protective construction.

9.3. **Equipment** As in the case of facilities, the choice of equipment will depend upon personnel recruited and assigned projects contingent in turn on the priority of fabrication technologies. A tabulation of recommended equipment and estimated costs is given in Table 4. It can be presumed that the equipment will be procured by a stretch-out budget for over a period of three years, which will allow recruitment of the professional staff, who will initially share the burden of actually operating the equipment and testing facilities, and the necessary technicians, laboratorians and crafts personnel.

9.4. A summary breakdown of the equipment costs is shown in Table 5 in comparison with the totals estimated in other mission studies. The equipment represents some median of the various commercial types and may be too high or too low by a factor possibly of ±25 percent. Some of the equipment need not be produced for months or one or two years, especially if appropriate professionals on technicians are not available. Hence the allocation of funds to develop the full strength of the Model Plastics Technology Centre would be spread out to possibly three years. One other means for conserving the limited funding would be to purchase resale items at substantially one half or less of brand-new cost from used machinery firms. Finally, some equipment and laboratory items may be procured on leasing arrangements.

V. Suggested operating budget for manning staff

10. A suggested annual budget for salances and wages at two levels of manning is indicated in Table 6. Devised as a working guide, this budget is intended to first, provide an initiating cadre of personnel, capable of moving into projects immediately or within one year and secondly, to provide an estimate of a fully-manned Centre within three years. At this latter time, the Centre would then be at a stage of preeminane and capable of justifying funding from its projects and programmes in demonstration of cost-efficiency in fabrication technology and equally important catalyze the technology for new outlets of indigenous plastics capacity.

10.2. The suggested initiating Cadre Strength (a) is included primarily to allow further adjustments in the minimum of personnel that could begin immediately the activities of the Centre to serve the indigenous plastics industry. Within reasonable confines, the initiating cadre strength could be further reduced, from a budget level of 399.400 U.S.dollar equivalent for the 0 - 1 year operations, to other, lower allocated figures.

10.3. However, it is emphasized that the eventual manning salary and wage budget in the third year (b) estimated at 558.400 U.S.dollar equivalent must be provided for by the end of the third year. This requirement is based on the expectation that the Model Plastics Technology Centre will attain sufficient prestige and competense to provide hard data for growth of the plastics fabrication industry and for long range planning by all concerned, namely the government, the industry, consumer projections, and so on.

VI. Financing mechanism

11. The financing of a Model Plastics Technology Centre in developing countries, as in the case of the parent physical concept, is no less indeterminate, not only because of the lack of precedence in such a venture, but more particularly because of the involvement of several agencies that have vested interests in the Centre and especially its mission and functions.

11.2. Nevertheless, and despite these involvements and duplicative, counter-purposes, an exercise in one composite and model financing can be attempted and justified. Such an exercise would represent a beginning from which some formula or proportionation can be considered. The financing formula and structure as herein suggested is no more than just that, a beginning for refining, adjusting or even proposing a new schema consistent with available means for financing.

11.3. To begin, Chart 3 presents a three year financing programme suggesting the participating of the following three agencies:

(a) extra-territorial sources,

(b) national, government budget,

(c) industry subscription, i.e., plastics resin manufacture and fabrication, and

(d) consumer industries subscription.

These various agencies have vested interests in the establishment of a model centre for reasons that are quite self-content. The one in particular that should support the budget of the Centre is the consumer industry (non-plastics) and agencies that consume or utilize plastics fabricated articles and large constructs. Typical of these would be the following, well-recognized consumers of plastics.

(1) Agriculture, for irregation, drainage constructs, bagging, containers, etc.

(2) Building, for housing, sanitation, hospitals, clinics, class-rooms, etc.

(3) Automotive, for truck bodies, replacement components, etc.

(4) Food and beverage, for packaging, bottles, etc.

(5) Furniture, domestic and especially institutional, such as hospitals and schools, plus the usual range of engineering, mechanical and electrical items in original equipment manufacture.

11.4. For the model financing on a cost inclusive basis, an arbitrary case of an already described investment cost for a laboratory for testing plastics, as reported in the 1969 Monograph (Petrochemical Industry Series, No.5, Establishing Standardization of Plastics in Developing Countries), is utilized with the adjustment for (a) increased space to accommodate the plastics fabrication area and (b) an arbitrary 15 percent inflationary increase in construction cost since 1969 and (c) dependence upon plastics materials of construction especially fiberglass reinforced panels, flooring, piping, and so on, to reduce the construction costs using the panels over minimal wood, metal or concrete support. It is obvious that if the Centre is to promote wider use of plastics materials, at least some significant share of the Centre building construction should be of plastics, notably reinforced fiberglass plastics. Finally, the Model Centre is adjusted to 4,500 square meter area in view of the 3,000 square meters area for the laboratory and an increase in office space from 1,000 square meters to 1,500 square meters. This is summarized with these adjustments in Table 7.

Suggested apportionment of financing

11.5. World Bank This agency should be approached from the view point of matching the land cost to be provided by the host country or pro-rated by each host country of the host region. In this Model Plastics Technology Centre, the World Bank could be requested to fund the physical plant constructions (Item 2 in Table 7) to the extent of 417,000 US dollar equivalent.

11.6. International (Regional) Bank or Agency This agency would make up the remainder of the construction (Item 2 in Table 1) to the extent of 768.660 - 417.000 or 351.660 US dollar equivalent.

11.7. Developed (vender) country sources This source comprise governments or financing institutions of developed (vender) countries that have some vested market interest in developing country, either in sales of equipment and machinery or in process know-how and should be solicited for funding fabrication and testing equipment amounting to 513,500 US dollars equivalent.

11.8. Host region or country sources The national, country or regional, source should be responsible for the land investment and installation of services, miscellaneous constructions, miscellaneous facilities and the architect fees, which now closes the capital construction and equipment costs.

11.9. Industrial institutes Having already been according a seat in the governing council, the industrial institutes, including the plastics industry institutes, should provide for allocated share of the operating budget based on some percentage sales of resin and sales of fabricated plastics articles plus special services project which include numerous extra-Centre activities such as co-ordination of standarization of materials and test of national normalization and international (ISO) standards.

11.10. Plastics and Petrochemical Member Firms Industries As with the case with the industrial institutes, the member firms should be approached to provide the bulk of the operating budget based on some percentage of sales or transfer costs of resins and sales of fabricated plastics articles since the Centre will have the responsibility for the growth of the indegenous plastics industry. It is the general and indeed the indispensible task of the Centre to monitor constantly the quality and uniformity of polymers and resins of all sources which are produced and then fabricated into end-use forms.

11.11. Long range budget plans It is the concept in this financing plan that after the initial capital funding, presumably by outside sources, such as the World Bank, regional financial institutions, governments of developed countries, and private banks and lending institutions, the long-rang budget plans should be prepared in advance, 3 to 5 years, with oonstant revision or adjustment so that in due course the budget of the Model Plastics Technology Centre may be sustained by member industry assessment and by contracted project work for other industries that may have an interest in increasing the market for plastics components.

11.12. A planning group or committee organized within the Governing Council should be accorded the responsibility for allocating funds for annual forecosts, in turn studied, reviewed and adjusted semi-annually.

11.13. Once committed to incorporation as an appropriate legal entity either in one country or as a regional combine, the continued viability and foreward looking competence of the Model Plastics Technology Centre should be an accomplished fact.

11.14. Allocating financial support of the Centre operating budget. In the matter of allocating financial support for the Model Plastics Technology Centre, it is suggested that an allocation from the member industries be made in relation to:

(a) annual plastics resin manufacturing and

(b) annual plastics fabrication.

Since each is a separate industry in a manner ofclassification, it is suggested that their respective annual volumes be assessed from statutory research and development allowances usually in the average of 5.0 percent, split 50/50 between research and application, the latter being synonymous with development.

11.15. It can be rationalized that both, the manufacturing and the fabrication industries inclusive impose their own inherent specifications on the plastics material. In the final analysis, the end-use item dictates consumer acceptance and economics, and will so dictate over the essential characteristics of the plastics polymer and specifications for the resin. Thus, fabrication technology will dictate the essential characteristics. Therefore, it is believed proper to set up an allocation schedule taking into account, so to speak, both the incoming plastics material to the fabrication and the outgoing fabricated article moving to the consumer.

11.16. In substance, a rational and equitable system for financing the operating budget, distinct from the initial capital investment, is to start from the annual production and annual fabrication figures for a given country or region to be served by the Model Plastics Technology Centre. The system is now outlined in the schedules for the operating budgets indicated in Table 9a and 9b. In this computing schedule, it must be recognized that these are pure assumptions for the averaged cost data and the stated research and development costs. The schedule of computation allows any assignment of these critical cost factors as may be agreed upon by parties concerned. However, it is a useful system to apply

and can be revised in consort with the opinions and preferences of the Governing Council.

11.17. For the initial, start-up of the Model Plastics Technology Centre, Table 9a provides a net allocation of US dollar 396,000 on an annual plastics tonnage anticipated of 16,000 MT/a with an actual case of a developing country, against an estimated cadre operating budget, exclusive of the capital construction and capital items, of US dollars 399,400. The deficit here is tolerable and, for book-keeping purposes could be equated by simply adjusting the computed factors applied in (7) and (9) of Table 9a.

11.18. Next, for the established operational phase of the Centre as shown in Table 9b the surplas of US dollars in the third year can be utilized for the following purpose:

(a) Return to the funding pool of the extra-regional financial institutions to build up a reserve for other plastic related projects

(b) Return to the host government or host regions assuming this is a regulatory requirement for future contingences such as maintainance and modernization of the Centre or expanding its missions and functions

(c) Re-allocated for additional procurement of machinery and especially laboratory equipment.

There may be other surplas dispositions, e.g., rebate to the plastics manufacturing or plastics application industry. Preferences for the annual balance on the operating costs versus funding will be a matter of indigenous judgement.

VII. Projects for the Model Plastics Technology Centre

12. Within the preview of the missions and functions of the Centre, there will be a series of development and evaluation projects to ensure maintanance of high technical standard, competence in fabrication technology, and developing novel articles and processes to guide the petrochemical and its consequent plastics industry into maximum utilization of their investment. These projects shall be clearly stated in terms of (a) immediate, substaining programmes to assist these industries and also to develop new markets and (b) long term programmes that will assure economic self-sufficiency of the member industries and also search out unique plastics application for the betterment of the national and regional needs.

12.2. Substaining programmes Of prime concern to the plastics industry, there are conceivably a number of sustaining projects for the Centre to assume with the following, topical programmes as examples:

(1) Routine assessment of standard and off-grade resins for performance in fabrication such as injection molding, extrusion and specialty fabrications in relation to acceptance for production.

(2) Preparing test data on fabricated articles as well as the resin material against conventional standards presented by ISO, ASTM, national standards, etc.

(3) Proofing new fabricating, operating conditions and mechanical innovations to production line for customer fabricators.

(4) Maintain continued economic assessment of fabrications with respect to earnings (profitability).

(5) Maintain fundamental chemical analyses and physical characterization for trends in changes not otherwise detectable by specification tests.

(6) Provide technical assistance on product (article) deficiencies, notably mechanical or environmental failures in relation to fundamental chemical and physical characteristics.

(7) Develop and evaluate plastics scrap rework systems and economics.

12.3. Long term programmes Taking cognizance of the fact that resin improvements and changes are constantly being developed for a number of reasons, the Centre directorate will be concerned with continued up-dating of its expertise in recognizing these changes and hence maintain development programmes. The following are suggested examples:

(1) Evaluate new cross-linkage grades of polyethylene for rotational casting from the standpoint of improved endurence and economic merits for national planning of future polyolefin polymer production and capacity.

(2) With regards to (1), procure on lease basis a pilot unit and prepare a detailed cost analysis for patent and know-how licensing.

(3) Evaluate formulations of polyvinylchloride resins for grades most suited to the regional climate and environment with consideration of developing a captive chemical intermediates industry.

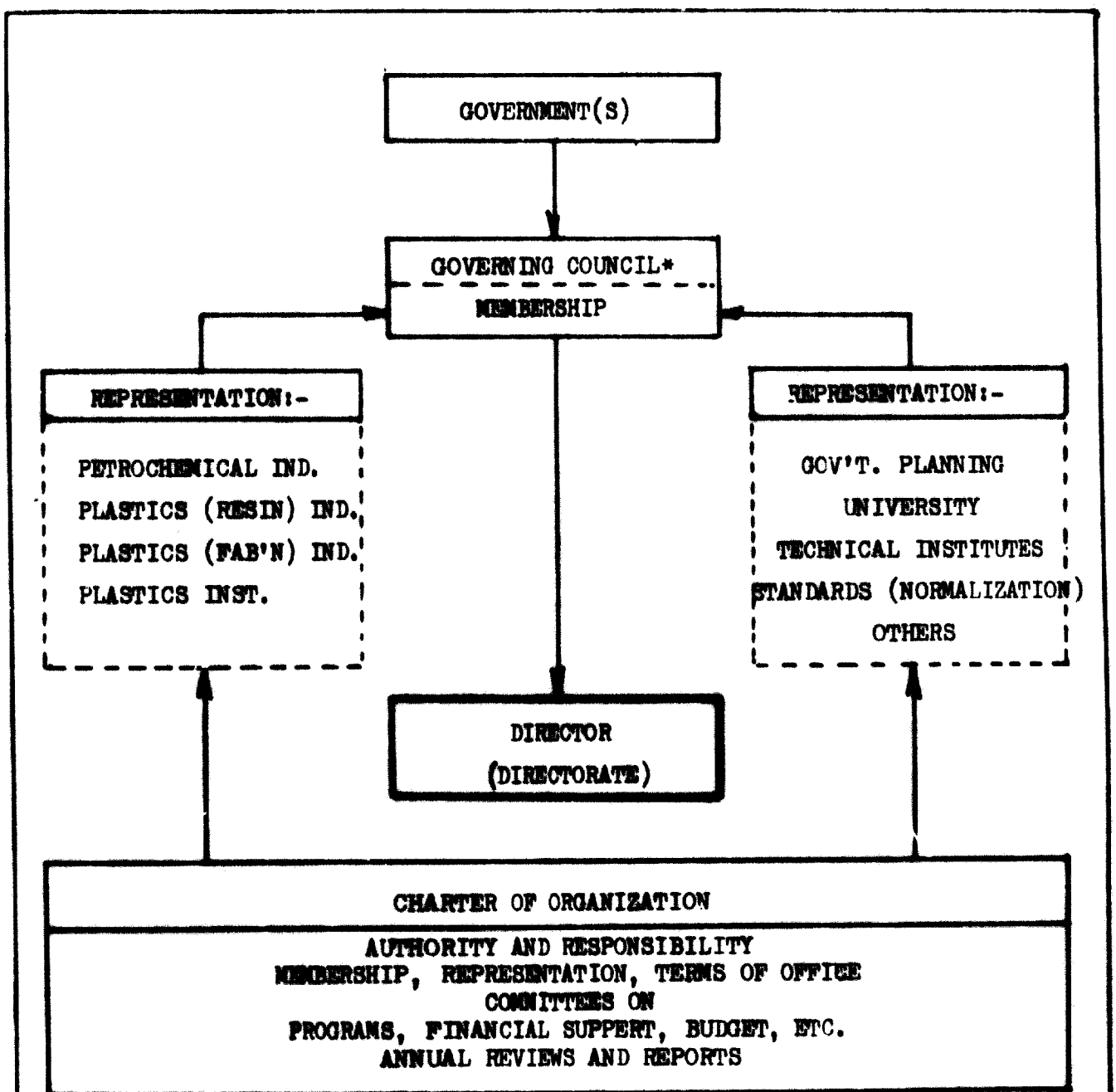
(4) Develop design concepts using plastics for inexpensive housing and institutional buildings.

(5) Provide technical information and data for national planning agencies.

(6) Provide on-the-job experience for plastics technologists and operating supervision personnel, prepared to undertake management responsibilities in plastics fabrication.

12.4. These are obviously illustrative programmes that may be overlapping in scope and objectives and it may therefore be a matter of priority for choosing the programmes more relevant to the needs of the plastics industry, rather than substantive devision as indicated here.

Figure : 1



(S) IF REGIONAL WHEN TWO OR MORE COUNTRIES ARE INVOLVED.

* Synonymous with BOARD OF DIRECTORS

CHART 1. A recommended derivation of a Model Plastics Technology Centre.

Figure : 2

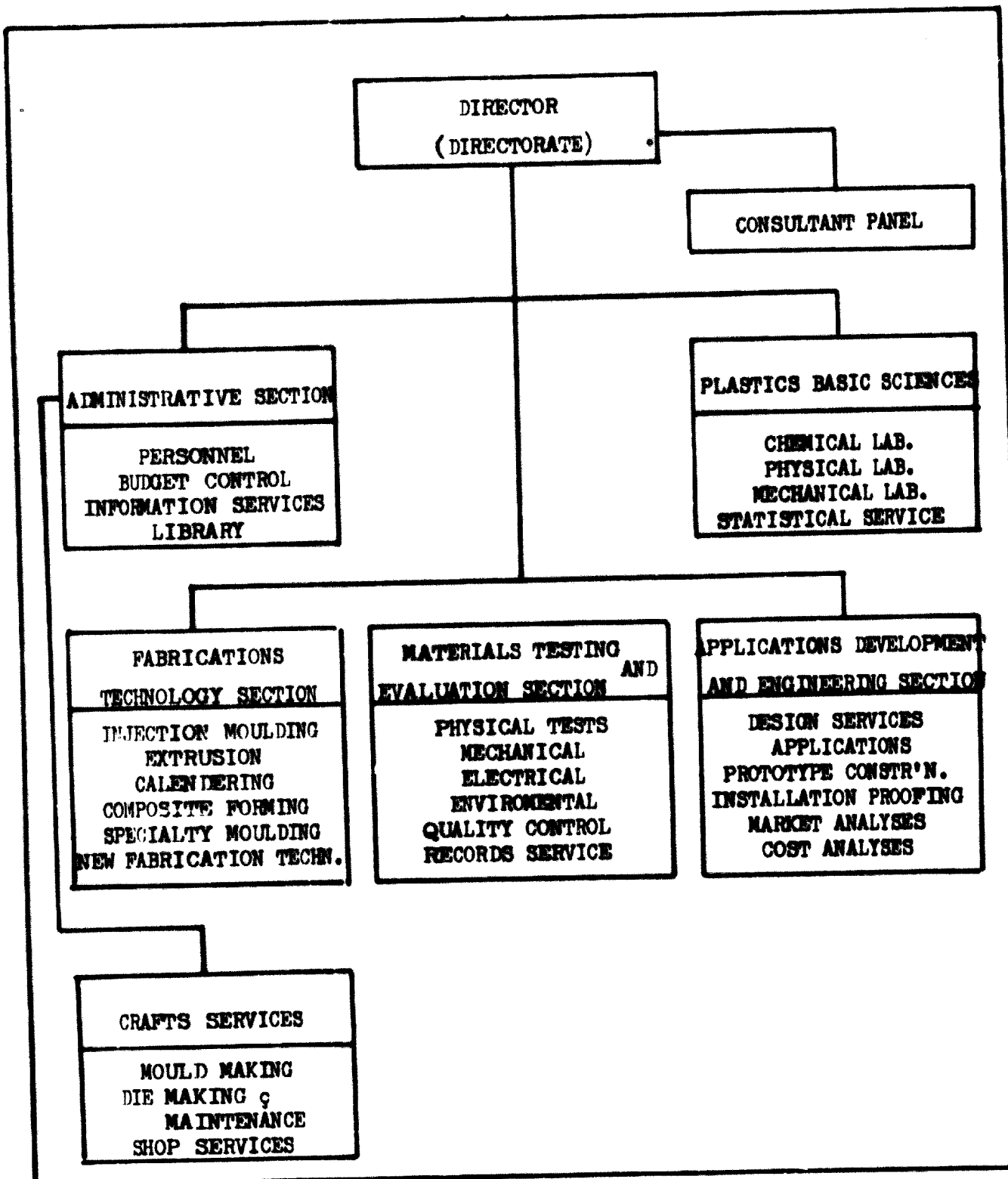


CHART 2. STRUCTURED ORGANIZATION OF
A MODEL PLASTICS TECHNOLOGY CENTRE.

TABLE 1.

AGGREGATE MANNING PERSONNEL FOR A MODEL PLASTICS TECHNOLOGY CENTRE

Section	Profes-sional	Technicians		Secretary Clerical	Crafts
		Laboratory	Operators		
Directorate	1(a)	--	--	1	--
Administration	4(b)	--	--	5	1
Fabrication Technology	3	--	6	2	5
Materials Testing and Evaluation	3	6	--	2	2
Applications Development and Engineering	4(c)(d)	--	--	3	--
Plastics Basic Science	4	4	1	1	--
Totals	19	10	7	14	8

(a) Does not include Senior Scientist serving as Assistant Director.

(b) Includes librarian.

(c) Includes draftsman.

(d) Includes cost-analyst (business administration degree or diploma).

TABLE 2.

Comparison of Suggested Manning Strengths

considered in selected UNIDO mission surveys.

Nature of Organization	Projected Plastics Production (Estd 1957) MT/a	Category					References UNIDO/ ITD
		Professional	Technician Operators Crafts	Clerical	Non-skilled	total	
Plastics Inst.-Chile	67.'50	(not indicated (n/i))					15
Plastics Techn. Centre Nicaragua	88.300 Central America	(n/i)	(n/i)			76	21
		6					
Applied Polymer Inst. Burma	~ 16.000	64	24	(n/i)	(n/i)	88	55
		88					
Standardization Lat.	---	60		20	(n/i)	80	Petrolium Ind. No 5
Compared with							
Model Plastics Centre		19	16	19	3	57	This draft study
		35					

(n/i) means not included.

TABLE 3.

Suggested space facility allocation for initial planning.

Centre Function	Space Square meters	Comment
Offices	400	5 modules of 80 sq. meters(a)
Laboratory	500	10 modules of 50 sq. meters
Fabrication Area	1,800	Open area with mobile equipment
Shops, storage and general reserve	1,800	1 shop area and 1 storage area
Total	4,500 (b)	

(a) Location to include information and file centre

(b) Compares with 4,000 sq. meters of Monograph No.5 (P15)

TABLE 4.

Table of recommended equipment and estimated costs

Description	Units	Unit Cost (Allowance)	Total Cost (Allowance)
Fabricating Equipment (s)		US dollars	US dollars
Injection molding-general pupose	1		22,500
-moulds and accessories			2,500
Injection molding - special projects	1		30,000
-moulds and accessories			5,000
Extruder - general purpose (SS)	1		12,500
-dies and accessories			6,000
Extruder - special projects (MS)	1		40,000
-dies and accessories			
Compression molding (lamination)	1		7,500
Calender mill (3-roll)	1		10,500
Banbury mixer (A-unit)	1		7,500
Turn-roll mill	2	5,500	11,000
Cube-cutting	1		2,500
Ovens (nylon vacuum, etc.)	4	(var.)	11,000
Burn-out bath (screws, plungers, etc.)	1		2,500
Sander, blast type enclosed	1		1,500
Sub-total			172,500
Materials and Product Testing			
Mechanical properties and standards, Tensile, flexural, compression	2	10,500	21,000
Impact properties:			
Film,	2	500	1,000
Mouldings	2	1,000	2,000
Tear	2	300	600
Abrasion	1	2,500	2,500
Hardness	2	2,000	4,000
Creep test, anxiliary components	-	-	2,000
Heat distortion testing units	2	-	5,400
Melt Indexer	2	1,600	3,200

Plastograph with accessories	1	7,500	7,500
Thermal conductivity	1	2,500	2,500
Water vapour transmission	2	1,200	2,400
Colorimeter (tricolor stimulus)	1	5,000	5,000
Electrical constants (D,K, etc.)	1	4,500	4,500
Electrical stress test	1	1,500	1,500
Torsion pendulum tester	1	5,400	5,400
Calculators, desk	3	1,800	5,400
Interface for AD conversion complete with tape	1	7,500	7,500
Sub-total			83,400
Chemical characterization and exposure			
Spectrophotometer IR	1	9,000	9,000
Spectrophotometer UV	1	18,000	18,000
Gas Chromatography	2	4,500	9,000
Gel permeaton chromatography	2	5,500	11,000
Atomic absorption	1	12,500	12,500
Polarographic analyzer	1	8,500	8,500
Weatherometer	2	7,500	15,000
Mass spectrometer (flame test)	1	22,500	22,500
DTA-TGA-DSC Analyzer	1	9,000	9,000
Autoclave	2	1,500	3,000
Microscope, optical	3	1,500	4,500
Microscope, SEM	1	17,500	17,500
General laboratory items	(var.)	15,000	15,000
Sub-total			154,500
Machine shop and mechanical items			
Lathe	2	5,500	11,000
Mill, general purpose with accessories	1	7,500	7,500
Mill, special computer programmed for mould replication	1	37,500	37,500
Grinder	2	2,500	5,000
Saw, band	1	4,000	4,000
Chrome finishing	1	5,500	5,500
Aluminium anodizer	1	3,500	3,500
Sub-total			64,000

Supporting Services			
Typewriters, varied	6	(var.)	3,000
Duplicator, desk, small	1	1,100	1,100
Duplicator, text, heavy service	1	12,500	12,500
Computer stations, TWX	3	7,500	22,500
Sub-total			39,100
Combined total			513,500
Furniture and furnishings			
Office desks	24		2,400
Work desks	15		750
Work benches and tables	20		800
Cabinets	(var.)	-	6,000
Shelves	(var.)	-	4,000
Laboratory bench			25,000
Laboratory shelves			7,500
Sub-total			46.450
Total, equipment and facilities (less land and building)			559,950

TABLE 5.

Recapitulation of equipment costs by functional (Section) categories.

	This Study Model PTC	Plastics Stand Lat.(a)
Fabrication	172,500	176,100
Testing - Phys., Mech., Elec.	83,400	362,629
Chemical Properties and Lat.,	154,500	229,260
Mechanical shop and crafts	64,000	13,900
Supporting, administration	39,100	(n/i)
Total	513,500	781,789
Furniture and furnishings	46,450	(n/i)
	559,950	(781,784)

(a) Monograph No.5 (Petrochemical Industry Series)

(n/i) means not indicated

(781.784) means that the estimate is incomplete in this case.

TABLE 6.

Operating budget for manning personnel in two levels.

Position Title	Manning level			
	(a) initiating Cadre		(b) developed established	
	No.	US.$ equiv.	No.	US.$ equiv.
A. Directorate				
Director, Centre	1	24,000	1	30,000
(Associate Director) (a)	-	—	(1)	(24,000)
Secretary (Senior)	1	5,600	1	5,600
Clerk	-	--	1	3,800
		29,600		39,400
B. Administrative Section				
Manager	1	16,000	1	18,000
Assistant Manager	-	—	1	14,000
Project Engineer	1	12,000	1	12,000
Librarian	1	10,000	1	10,000
Secretary	1	4,800	2	9,600
Clerk, file	1	—	1	3,200
		42,800		66,800
C. Fabrication Technology Section				
Manager		16,000	1	20,000
Plastics Engineer, Senior	1	14,000	1	18,000
Plastics Engineer, mould design	1	13,000	1	14,000
Operator, Supervisor	1	10,000	1	10,000
Operators	2	12,000	5	30,000
Machinist, Foreman, crafts	1	7,200	1	7,200
Machinist, crafts	2	12,000	2	12,000
Secretary	1	4,800	1	4,800
Clerk	1	3,200	1	3,200
Maintenance, general	1	1,800	2	7,200
		93,000		126,400

D. Materials Testing Section				
Manager, materials science	1	16,000	1	20,000
Assistant Manager	–	--	1	16,000
Technologist, quality control	1	12,000	1	14,000
Technicians, testing	3	18,000	6	43,200
Technician, electronics	1	7,200	1	10,000
Technician, mechanics	1	7,200	1	7,200
Secretary	1	4,800	1	4,800
Clerk	1	3,200	1	3,200
		68,400		118,400
E. Application Engineering				
Manager	1	16,000	1	20,000
Engineer, mould design	1	12,000	1	16,000
Engineer, structural design	1	12,000	1	16,000
Engineer, cost analysis	1	12,000	1	14,000
Draftsman	1	7,2000	2	16,000
Model craftsman	1	6,000	2	15,000
Technician computer	1	7,200	1	7,200
		72,400		104,200
F. Plastics Basic Science				
Manager (Associate Director)	1	20,000	1	24,000
Scientist, polymer chemistry	1	16,000	1	16,000
Scientist polymer rheology	1	17,000	1	17,000
Scientist, polymer physics	1	18,000	1	18,000
Laboratorians	3	18,000	4	24,000
Secretary - clerk	1	4,200	1	4,200
		93,200		103,200
Combined total		399,400		558,400

TABLE 7.

Summary of Investment Cost, inclusive capital construction costs.

	Area sq.m	US $ Equiv.	US $ Equiv.
1. Land	15,000		417,000
2. Construction			
a. Plant (Centre)	* 4,500	575,460	
b. Office	1,500	172,500	
c. Land readjustment	-	20,700	
			768,660
3. Fabrication, testing equipment, furniture and furnishing (Table 4)			559,950
4. Installation of service			435,980
5. Miscallaneous construction			76,700
6. Miscellaneous fixtures			42,100
Sub-total			2,300,390
7. Architects design and supervision			230,040
TOTAL			2,530,430

* Working example for the plant starting from 3.000 sq. meters, 1969-1972 with 15 % annual construction cost increase and with an estimated 20 % savings due to use of plastics constructions (e.g. panels, furniture, etc.). Thus starting from the $ 417,000 figure of Monograph No.5 we obtain

$$(417{,}000) \times \left(\frac{4{,}500}{3{,}000}\right) \times (1.15) \times (0.80) = 575{,}400.$$

TABLE 8.
Suggested financing of A Model Plastics Technology Centre in developing countries.

Cost item	Combined capital construction and operation budget (US. $).			
	1st year	2nd year	3rd year	4th year
1. Capital construction (Table 1) maintenance, modernization	2,530,390	--	--	50,000
2. Operating budget (Table 6) Cadre (starting)	399,400	478,900	--	--
Full strength			558,400	586,320
3. Contingencies (Allowance) Material procurement	10,000	15,000	15,000	25,000
Special service, projects programs (ISO) etc.)	15,000	20,000	25,000	25,000
TOTAL	2,954,790	513,900	598,400	686,320
4. Funded by:				
World Bank (minimum)	417,000	--	--	--
Regional bank	351,660	--	--	--
Developed (Vender) country	559,950	--	--	--
Host Region / Host Country	1,201,780	--	--	--
Industrial Institutes / Plastics Institutes	15,000	20,000	25,000	25,000
Resin Manufacturers / Plastics Fabrication firms	409,400	493,900	573,400	661,320
TOTAL	2,954,790	513,900	598,400	686,320

TABLE 9a

Part A. Estimating Equitable Funding Schedule for initial operating budget.

Purpose

To compute initial allocation of financial support by the plastics manufacturers of resin and the plastics fabrication firms.

Basic Assumptions (Hypothetical Case)

(1)	Annual plastics resin production	16,000	MT/a
(2)	Annual plastics fabrication (conversion)	16,000	
(3)	Average annual resin transfer cost (price)	US$ 0.33	1 kg.
(4)	Average annual fabrication cost (price) factor of 2 x (3)	US$ 0.66	1 kg.
(5)	Average R & D allocation polymer production		
	(a) Research and development	5.0	%
	(b) Development (application) share	2.5	%
(6)	Average R & D allocation - fabrication		
	(a) Research and development	5.0	%
	(b) Applications (development) share	2.5	%

Computed allocation for the Model Plastics Technology Centre	
(7) From plastics (resin) production (Item 1).1000.(Item 3).(4f) (16.000)(1000)(0.33)(0.025)	US$132,000
(8) From plastics fabrication (conversion) (Item 2).1000(Item 4).(5b) (16.000)(1000)(0.66)(0.025)	US$264,000
Net allocation for initial operating budget	US$396,000
(compare with Table 6, deficit)	US$(399,400)

TABLE 9b

Part B. Estimating Equitable Funding Schedule for established Centre operating budget

Purpose

To compute allocation of financial support by the plastics manufacturing of resins and the plastics fabrication firms in the third year of Centre operation. (Assumes growth of annual plastics production tonnage from 16,000 to 30.000 MT/a.)

Basic Assumptions

(1)	Annual plastics resin production		30,000	MT/a
(2)	Annual plastics fabrication (conversion)		30,000	MT/a
(3)	Average annual resin transfer cost (price)	US$	0.33	/ kilo
(4)	Average annual fabrication cost (price) factors of 2 x (3)		0.66	/ kilo
(5)	Average R & D allocation polymer production		5.0	%
	(a) Research and development		2.5%	
	(b) Development (application) share		2.5%	
(6)	Average R & D allocation plastics fabrication		5.0	%
	(a) Research and development		2.5%	
	(b) Development (application) share		2.5%	

Computed allocations for the Model Plastics Technology Centre

(7)	From plastics (resin) production (Item 1).1000.(Item 3).(4b) (30.000)(1000)(0.33)(0.025)	US$	247,500
(8)	From plastics fabrication (conversion) (Item 2).1000.(Item 4)(5b) (30.000)(1000)(0.66)(0.025)		495,000
			742,500
Net allocation for operating budget compared to 3rd year operating budget (Table 6)			660,635
Surplus for contingencies, procurement of new equipment and new technology.			81,865

DEFINITION OF TERMS

Explanatory note

In this presentation a number of terms have been used in a meaning that may often be quite different from that implied in the other technical and non-technical discourse. This appendix provides now appropriate definitions to clarify or perhaps restrict the meaning of selected words applied in developing the concept of a Model Plastics Technology Centre.

Crafts

Skills or trades related to mechanics, machinists, welders, pipe-fillers, electricians, etc.

Formulation

Additives added to a polymer, usually direct from the polymerisation, in a blend most suited for providing either processability or some end use feature or both.

Laboratorian

One who has acquired a technical experience, without formal institutional background training, in laboratory practise with competence to follow and maintain procedural practises and maintenance of laboratory equipment.

Plastics

A general connotation of an industry or a plurality of fabricated articles. A careful distinction is made between such a meaning and the substantive description of the precursor materials, notably polymers and resin which in themselves connote different states as further delineated by definition of these terms in the Appendix.

Plastics engineer

One who has a recognized institutional baccalaureate degree or diploma attesting to training that will qualify for the manufacture of plastics articles. Usually trained formally in scientific disciplines, a plastics engineer acquires this competence by supplemental experience with plastics fabrication.

Polymer

A high molecular weight chemical entity that is definable in terms of chemical and physical properties. A distinction is made that for finishing purposesand required mechanical nnd service endurance, a polymer is not necessarily a finished item for the consequent fabrication. It is usually compounded and physically modified from a raw polymerization product to what is usually referred to as plastics resin or simply resin.

Professional

A person having attained a university or institutional degree equivalent to at least a baccalaureate.

Project

A major undertaking in the nature of studies of process and materials, including economic forecasts or projections, or fabrication compaigns requested of the Centre involving some major expenditure of manpower and expense with stated technical or economic objectives. It differs from programmes which on arbitrary basis represent a segment of a project or a sustaining activity of the Centre.

Programme

A specific activity of the Centre involving some narrow and well-defined task, survey, or expedient collation of data. The term is arbitrary but intended to draw distinction from a major activity involving major expenditure of manpower and expense.

Resin

A compounded physical form of polymer with specific additives that qualify to specified grades of the plastics trade.

Subscription

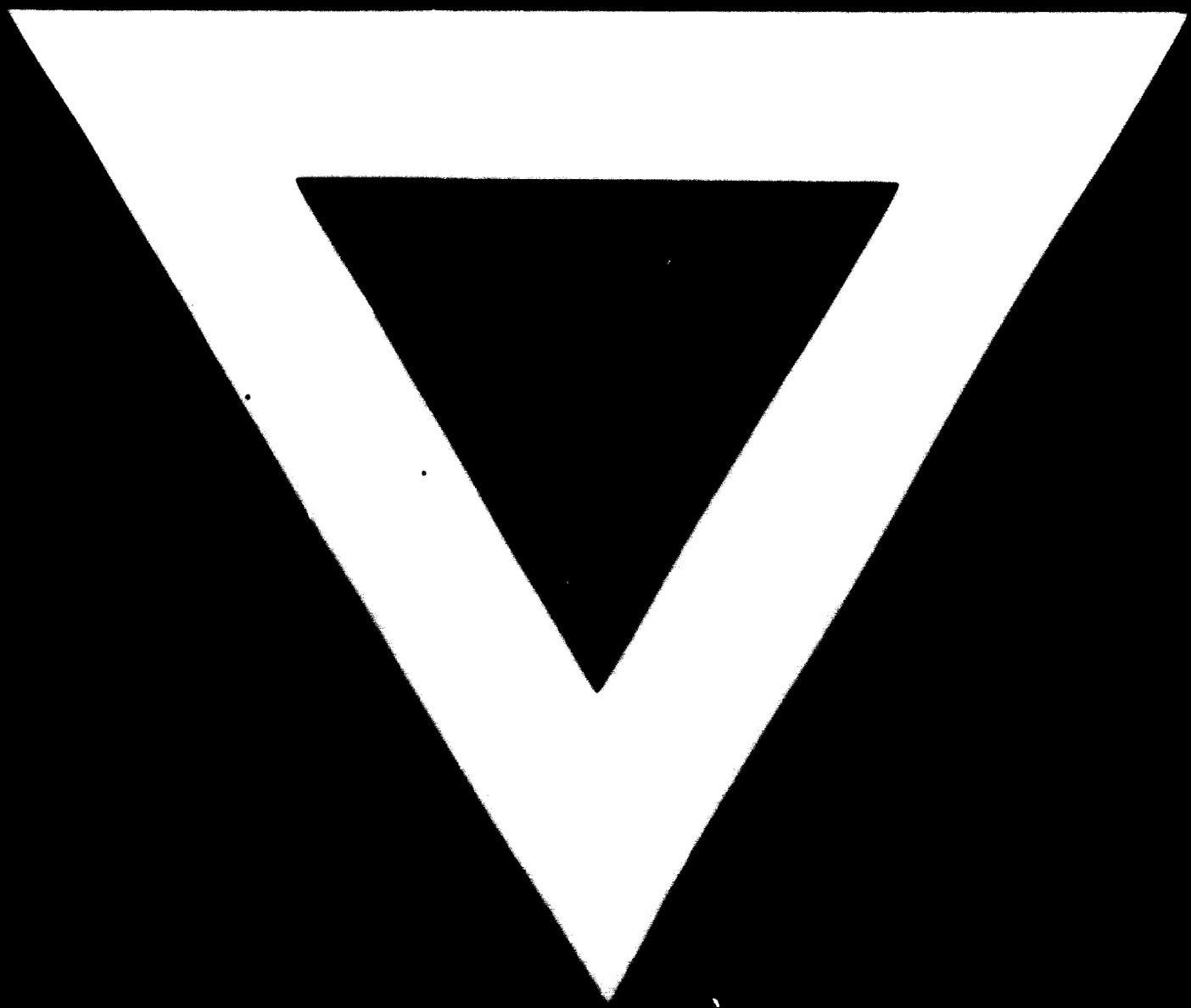
Referring to financial support for the Centre, a means of funding based on some annualized sales of plastics articles.

Technicians

One who has required experience, without formal institutional background training, in plastics technology and may have a specialty in one or more types of plastics fabrication or testing prodecures. (This item is different from the statutory interpretation in some countries where a technician is on par with the definition given here for a professional.)

Vendor

Referring to selling country, whose industrial firms have an established trade in machinery, equipment and know-how for the plastics industry of the developing country.



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