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United Nations Industrial Development Organization

Distribution
LIMITED

ID/WG.9/10
17 June 1968

ORIGINAL: ENGLISH

Interregional Seminar on Industrial Location
and Regional Development
Minsk, August 1968

REGIONAL LOCATION AND EFFICIENCY OF INDUSTRIAL COMPLEXES IN RELATION TO THE PROVISION OF INFRASTRUCTURE 1/

by

John A. Shubin

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REGIONAL LOCATION AND EFFICIENCY OF INDUSTRIAL COMPLEXES IN RELATION TO THE PROVISION OF INFRA-STRUCTURE[1/]

SUMMARY

by

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* This is a summary of a paper issued under the same title as ID/WG.9/10

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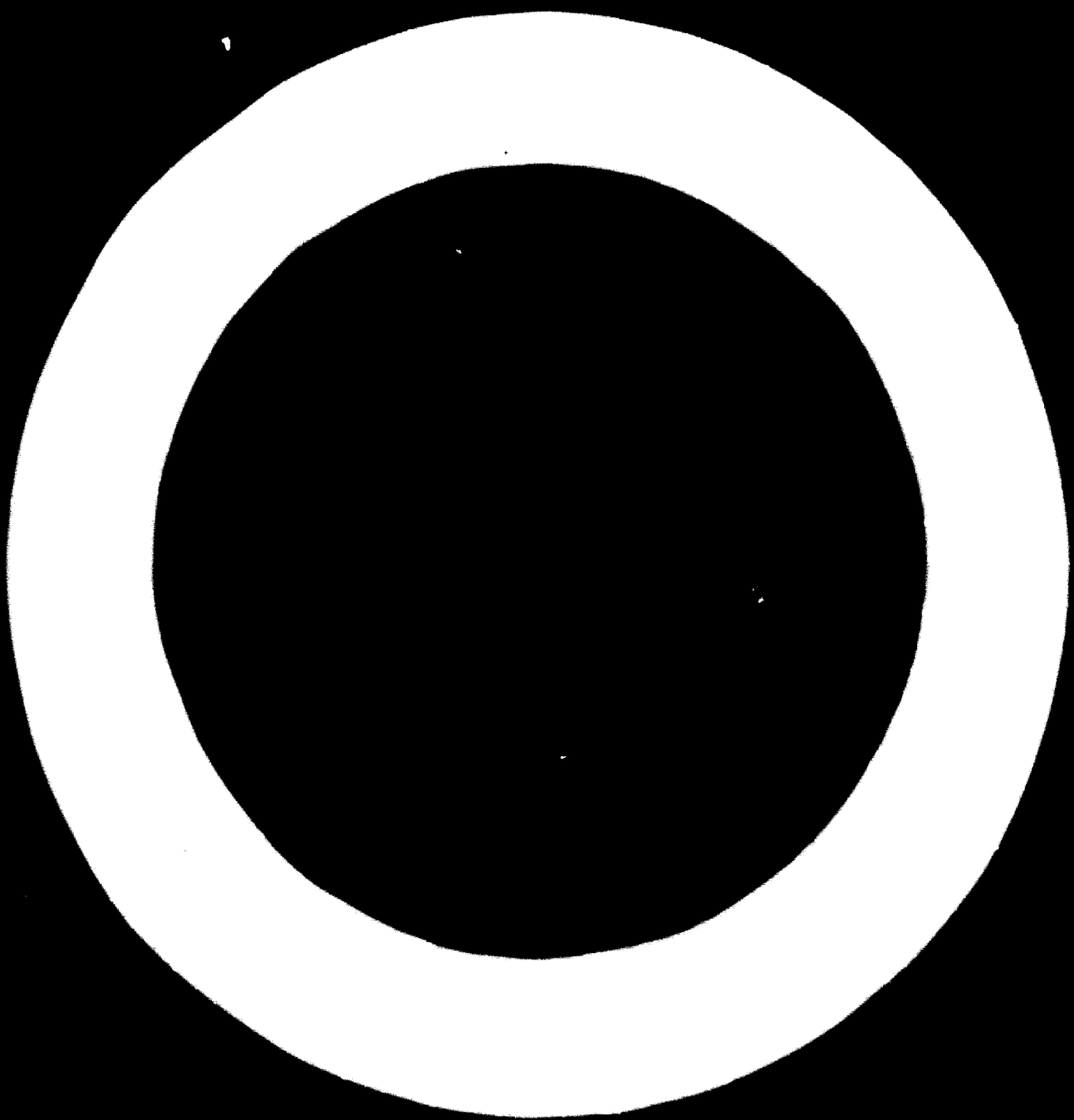

1. This study analyzes industry-infrastructure relationships and the provision of transport and power within the context of the development of an industrial structure designed for accelerated growth.

2. Industries in a given geographical situation dictate the infrastructural requirements, but the infrastructure, too, determines the kind of regional industries and industrial structure that are economically feasible. The introduction of an industrial structure appropriately designed for underdeveloped regions helps to bring about high utilization of plant and infrastructure (transport and power) capacity.

3. An industrial structure of high productivity is designed (as outlined in the study) on the basis of a rationalization of industrial production, design of specialized production centres, and an application of analysis and an appropriate location procedure to obtain a rational industry-location pattern (a projected regional division of labour)

4. Effective planning for industrialization and for an economic provision of infrastructure is based on a region's projected industry-location pattern and its pre-designed transport and power systems. Such planning permits rational long-range programming of infrastructure; it can erect a pre-designed infrastructure system in logical stages and in well prepared schedules that ensure adequate services for industries at comparatively low investment. It also erects plant capacity in a constellation of related industrial centres to obtain high utilization of infrastructure and economies of scale.

5. In developing countries the typically small markets for specific goods impede the establishment of modern industry for the output of goods for domestic consumption. Continual advances in industrial technology, moreover, enlarge the output capacity of economic-size plants. Not withstanding these impediments, practical approaches for industrial development are available; industrial plants can be introduced in developing countries on an economic basis.

6. The successful economic growth of smaller countries requires that they be economically integrated into larger common market regions. Economic integration makes it possible to obtain an efficient utilization of resources through regional division of labour.

7. The procedure for locating economic activities to obtain geographical specialization of production (regional division of labour) and the approach for designing the structural organization of industry and infrastructure requires analytic methods appropriate to the conditions of developing countries. If they are to design the structure of industries for developing areas, planners must look to the economic and the relevant technological attributes of industry and infrastructure, and to the interrelations among industries and economic areas.2/

8. An analysis of the industrial structure and the production technology of industrialized countries points to alternative structural arrangements and organizational adaptations appropriate to underdeveloped areas; and it indicates the structural designs of industry and the development approaches fruitful for achieving accelerated industrialization.

9. A realistic approach to economic growth demands a long-range, over-all analytic approach to economic development. Planners must design and project a region's sector mix and its structural pattern for the development of industries if they are to programme integrated economic development and fully exploit the growth-and-productivity potential inherent in regional division of labour.

10. Viable industrial programming for accelerated expansion and the economic provision of infrastructure can be obtained on the basis of a pre-determined geographic specialization of industry, the rationalization of production, design of specialized production centres, design of infrastructure systems, and related approaches.

2/ The planner derives his approaches from the "demonstration effects" of industrialized countries. The planner must not only look to historical stages and processes of economic growth, but to the nature of the evolving industrial system and technology and to insights into available structural potentialities and procedural schemes.

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II INFRASTRUCTURE PROVISION FOR REGIONAL INDUSTRIAL COMPLEXES

Interrelationships in the programming of infrastructure and industry

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I REGIONAL LOCATION AND EFFICIENCY OF INDUSTRIAL COMPLEXES

11. The ideal location for an industry is determined on the basis of the lowest long-term cost of production and distribution of goods. The selection of a location for an industrial enterprise must take into account the future size of the market, the future cost of input factors and transportation, and the advantages of proximity to complementary industries.

1/ The planner derives his approaches from the "demonstration effects" of industrialized countries. The planner must not only look to historical stages and processes of economic growth, but to the nature of the evolving industrial system and technology and to insights into available structural potentialities and procedural schemes.

Location analysis and procedure

12. By appraising the comparative advantages of alternative locations on the basis of an industry's future cost (the relevant cost) or production and distribution of goods, planners can determine the net impact of the different location determinents (the location pulls). The long-range approach for locating industries and industrial complexes in a developing country differs from that of locating industrial plants in an advanced country.2/

13. Many of the external pulls (availability of suppliers, specific markets for goods, and so on) that influence the location of a plant or an industrial complex in an advanced country become, in a developing country, internal interrelationships among the industries involved in the over-all location procedure for determining a region's pattern of geographic specialization of industries. Long-range planning for developing regions deals with relatively dynamic development and industrial programming which essentially creates its own economic environment. When a planner simultaneously locates industries on the basis of mutual comparative advantage, he creates a specific economic environment for production. If they are to locate industries for geographic specialization and high productivity, planners must, at the outset, locate industries and project infrastructure two decades or more ahead.

14. By employing appropriate economic analysis, planners can attain a highly productive location pattern for industry and economic activity. In their analytic approach, they may be able to avoid the emergence of excessive geographic concentration of industry, while attaining specialised production centres or districts of appropriate size.

15. Planners can project a region's future sector mix and geographic specialisation of industry through an analytic location procedure that takes into account geography

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2/ The location and the erection of an industrial plant in an advanced country involves a comparatively small capacity increment to total industrial capacity of the economy. Even though a new industrial facility is large, its location in an advanced economy essentially involves a small capacity adjustment and increment to an existing industrial structure and environment and pattern of geographic specialization of production. Plants that are poorly located, or locations that have become obsolete because of technological or economic change, would operate under high costs. Producers in high-cost locations are eliminated in the long-run by the competitive process, while rival producers in favourable locations typically expand capacity, thereby contributing to the emergence of geographic specialisation of industry.

and resource distribution, projected population, projected industrial technology, and stipulated goals for economic growth.

16. The procedure for obtaining an efficient geographic specialization of industries calls for: (a) a resource survey and an evaluation of the potentialities of modern transportation and power supply; (b) the designing of specialized production centres and industrial complexes on the basis of technological interrelationships and in conjunction with the geographic situation of resources; and (c) sequential locating of plants and industrial complexes on the basis of long-term comparative advantage, computed in terms of future costs for the relevant time horizon.

17. The analytic procedure for locating economic activities involves a chain-reaction path and feed-back interrelationships among vertical stages of production and among geographic areas. In the approach for determining and projecting the locational pattern of economic activities, planners, therefore, employ a sequential procedure (with systematic back-tracking) for successively locating industries and economic activities on the basis of a resource survey and industrial analysis.

18. Through regional analysis planners identify areas of resource adequacy and high growth potential as well as areas of low economic potential, such as arid zones and inaccessible rugged terrains. Resource surveys and industry studies can produce and project a future industrial geography (a pre-determined industry-location pattern) that consists of a distribution of industries based on resource availability and areas of high growth potential. Because most larger regions include areas of low productive potential, an industry-location pattern would generally consist of a "spatially unbalanced" pattern for regional development.

19. A long-range projection of a pre-determined location pattern for industry for two decades or more into the future is, in many ways, vital to the attainment of effective economic development. It provides, for instance, the means for designing a rational regional infrastructure system and for programming the provision of infrastructure on an economic basis.

20. Planners begin by locating resource-based industries and extractive industries (crop production, mining, fisheries). On the basis of the distribution of fuel resources, they provisionally plot the pattern of the future interconnected power system; the projected lower cost supply of electricity gives planners greater locational flexibility for situating a range of industries. Planners outline an

emerging spatial pattern for economic activity by delineating the areas for agricultural processing industries, basic chemicals, and other early-stage production. They can then tentatively project the transport routes that will make up the future transportation system.

21. The location pattern of resource-based industries and specialized agricultural areas (the "independent" locations) pre-determine the location of many intermediate-stage and late-stage industries. Planners take into account the fact that industries and areas engaged in resource-based production become important markets (on the basis of derived demand) relevant to the location of certain market-oriented industries.

22. In order that they may allocate industries on a regional basis, planners determine whether an industry-divisional unit or an industrial complex is essentially material-oriented, fuel-oriented, labour-oriented, or market-oriented in its location. Then, to locate plants and industrial complexes for economic production for the long run, planners take into account accessibility to the market area or the consuming industries concurrently being located, the location of material sources, the extent of weight loss of materials during processing, projected transport costs, special requirements in terms of power and water inputs, and the projected location of industrial districts consisting of complementary enterprises.

23. In a given geographic situation and resource endowment, the best location for a plant or an industrial complex engaged in one or more stages of a series of production stages depends on the locational situation of the preceding or the subsequent stage, on the advantages of locating separately or of locating at projected districts of complementary enterprises so as to reap the economies offered by a specialized production centre.

24. The locational situations of late-stage industries, service industries, and locales of construction activity identify the consuming industries and areas that call for such inputs as semi-processed agricultural products, building materials and semi-fabricated metal products; therefore, they indicate which supply sources (which early-stage industry location options) are advantageously situated for access to larger markets and for economical distribution.

Resource-based industries

25. Many agricultural-processing industries must necessarily be situated near the source of their raw materials. The influence of raw materials on location

decisions depends not only on the future cost of transportation, but also on the bulkiness and the perishability of the raw materials and on the extent to which production processing brings about weight losing during conversion of the materials into a more finished state. Weight-losing materials attract processing plants to the source of the raw material.

26. For certain resource-based industries only a limited number of locations are available. This location rigidity stems from the fact that raw materials are situated at only certain places, as in the case of copper and nitrate deposits. There are, however, alternative location choices for material-oriented industries that process raw materials which are somewhat widely distributed. Moreover, the continual development of new sources and new kinds of materials, and improvements in transport technology provide alternative location arrangements for industry in developing countries.

27. This offers many opportunities for designing industrial complexes and specialized production centres consisting of more or less techno-economically related enterprises. The kind and the extent of division of labour that can be developed depends not only on a region's resource endowments, but also on the ingenuity for exploiting the potentialities offered by new production technology and new transport and power technology.

28. A region's topography, the locational configuration of its agriculture and other resource-based industries, and the situation of projected industrial areas determine the general routes of transportation and identify the sources of, and markets for, power.

29. By projecting the future outputs of agricultural areas and the future transport routes and crossroads, planners identify centres where processing mills and plants can be located for high productivity. Major transportation centres (main-route junctions) in rural areas frequently provide the "growth points" suitable for situating processing industries, schools and experimental stations, equipment repair shops, and marketing centres. Extractive and resource-based industries (distilleries, pulp mills, lumber mills, ore reduction mills, etc.) should, wherever possible, be developed in the vicinity of and, spatially integrated with, agricultural-processing industries so as to promote the joint development of local infrastructure and to trigger the emergence of industrial areas.

30. The environs of major transport junctions containing the foregoing economic activities and facilities may be projected to evolve into larger towns favourable for locating industries oriented to the agricultural sector, such as that of the production of farm machinery and implements, local meat packing, tanneries and fertilizer plants.

31. Thus, the delineation of the specialized production of richer areas and the projection of power supply and transport routes identifies major transport centres and bulk-breaking points that offer favourable areas and situations for locating those material-oriented processing and manufacturing industries that profitably exploit the resources of the general area, and those market-oriented industries that are drawn to the general area for economical production and distribution.

Market-oriented industries

32. Among the industries that seek a location readily accessible to their major markets are industries which produce bulky or perishable goods, and involve high transportation costs for shipping goods to the market. Market-oriented industries also include those establishments that require market accessibility for effective technical servicing of and communication with consumers and those that require a connexion with market developments and consumers' behaviour to ascertain style trends.

33. Modern industry is basically engaged in specialized production - many industries are engaged in the assembly of standardised final products such as appliances, business machines, communication equipment, and agricultural machinery. Assembly plants are typically market-oriented; they locate more or less centrally with respect to their over-all markets. Producers of parts and sub-assembly units also locate centrally for economical distribution to assembly plants and other industrial buyers of their products.

34. Producers design products to incorporate standard interchangeable sub-assembly units (motors and compressors, transmission devices, control devices) and other "common" components, all of which are decidedly more economical to buy from specialised manufacturers than to produce.

35. The industrial system nurtures different types of industrial complexes.3/ For example, an industrial complex (a multiple-plant unit) may consist of two or more stages of a series of successive stages of production from crude raw materials to the final product; it may consist of a cluster of plants putting out two or more products from a raw material (that is, engaged in the output of a material-related product line); it may consist of a multiple-plant unit that employs processes for the joint output of two or more related products (that is, engaged in the output of a process-related product line); or, it may consist of more or less integrated establishments engaged in activities (the preceding, the following, or the allied activities) related to a major activity (for example, publishing).

The rationalization of industrial complexes and regional location

36. The geographic specialization of industry on the basis of the available highest productivity decrees the rationalization of industrial complexes and production of each homogeneous industrial sector, for example, the light-engineering sector or the electrical engineering sector. A rationalization programme employs selective analysis and a number of related industrialization approaches that assure accelerated industrial development.

37. The active responsibilities of a rationalization programme are to:

(a) Design plants and industrial complexes to obtain the production adaptability necessary for developing countries;

(b) Design and locate industrial complexes to obtain the available economies from vertical integration;

(c) Formulate approaches for setting up minimum economic size plants and industrial complexes required by developing countries;

(d) Employ a broad product-design approach that permits industrial sectors to maximize the adoption and the output of common components, such as standard interchangeable sub-assembly units, parts, and materials;

(e) Organize and set up plants and industrial complexes on the basis of process-related product lines to obtain a large volume of work for output by mass-production facilities;

3/ An industrial complex is an interrelated multiple-plant unit (embodying production, marketing, or other activities) located at a given site for the output of goods or services. When an industrial complex operates on the basis of current technology and organization, the physical separation of a single activity or facility from the site increases its cost of operation, whereas, the expansion of a complex to a given level of output sometimes makes it economical to add a related activity or facility. Because of the size of local markets and transport costs, sub-optimal industrial complexes can be profitable, multiple-plant units.

(f) Group techno-economically related plants and complexes to make up specialized production centres or districts that obtain high productivity and intensive use of infrastructure;

(g) Design the type of industrial structures that promote mutual locating of industrial complexes and the setting up of specialized production centres for regional division of labour;

(h) Design a projected industrial structure that enables the programming of integrated industrialization - the programming of related projects that erect vertical segments of capacity and techno-economically related facilities and concurrently provide complementary infrastructure to assure economic integration.

The foregoing industrialization approaches are elaborated upon in the pages following.

38. For developing countries, an adaptable plant or industrial complex has particular value because of its ability to turn out a comparatively wide range of products and low investment requirement for conversion of plant to another line of output or for expansion of plant capacity.

39. Process engineers can readily design plants and industrial complexes for ease of adjusting or converting processes to meet changes in the products to be put out as well as for ease of inaugurating multiple-shift production to meet peak output requirements. Engineers attain additional production adaptability through the use of a process-layout arrangement for plant machinery, wherein the constituent departments or plants consist of a given type of processing equipment, as is exemplified by press shops, machine shops and welding shops. Plants organized on the basis of a process layout and judicious use of general-purpose machines are highly adaptable with respect to the introduction of new or redesigned products and to ease of expansion. The pre-planning and provision for production convertibility prior to the erection of a plant lowers the capital outlay that would be required for plant change-over to the output of other types of technically-related products.

40. A vertically-integrated industrial complex is generally a multiple-plant industrial division consisting of sequentially-related plants at a given site. Detached mills and facilities that are situated at a distance from the complex proper can be likewise more or less integrated with the "works" division as ancillary plants or auxiliary facilities. The processes or services of the detached facilities would be technically designed specifically to meet the production requirements of the industrial complex.

41. The economies of vertical integration derive from the reduction in over-all inventory stocks required, utilization of more specialized facilities, and the elimination of some beginning or terminal operations and equipment, such as those that involve furnace heating, inspection, packaging and crating, handling and storage.

42. In order to reduce investment in plant and to obtain steadier utilization of plant capacity, an industrial complex may be designed for partial or "tapered" integration, wherein the capacity of the earlier-stage plants is limited to meet the output requirements of the normal level of business. The additional output required to meet peak-production periods is covered by purchases from sub-contractors who supply fabricated items and components for further processing or assembly by the later-stage plants equipped with the required output capacity.

43. An industrial enterprise integrates either forward or backward (acquires sequential plants) when the return on investment for earlier-stage or for later-stage plants is higher than the return on its alternative investment opportunities. As a vertical complex grows in output capacity (scale), and as technological innovations introduce capital-savings production methods or improved materials, which are more economical to process, producers typically find it economical to erect an earlier-stage plant to produce components and materials that have become cheaper to make than to buy from suppliers.

44. The number of vertical complexes that emerge or that can be designed from the entire cycle of production stages in a given line of output (for example, in metal fabrication, textile, or food industries) depends on the volume of similar goods or related production that planners can group for a product coverage, the location of the major market(s), the geographic situation of resources, and the ingenuity of industrial planning and engineering. Planners, in their long-range design and projection of regional development, can frequently locate highly integrated industries by identifying and securing favourable geographic situations wherein the required materials and other inputs (fuel, power, or water) are located in close proximity and are also advantageously situated for accessibility to the major markets for the goods produced.

45. The optimum size and the minimum economic size plant or industrial complex differ among industries because of differences in plant divisibility, capital intensiveness, length of the production cycle, and the sources of economies of scale. The economic size production unit increases over time due to the emergence

of high-speed machines and processes, improved materials that process faster, and more intricate products which require a longer production cycle for their output.4/

46. The capacity balance among comparatively indivisible production and service equipment and facilities is obtained more readily in the higher range of rated capacity.5/ Because of the high productivity and comparative indivisibility of facilities in certain fields of industry, transportation and power supply, increases in scale (in output capacity) can be made only in relatively large increments.

47. An efficient smaller plant or complex (a smaller-volume minimum economic size unit) can be economically obtained by specifying a product line consisting of economy model products, designing products for output on less capital intensive facilities, organizing plants on the basis of a process-layout pattern wherever possible, and carrying out sub-contract work on the high-capacity under-utilized facilities. The aggregation of techno-economically related plants and complexes into specialized production centres promotes the joint use of high-capacity, capital-intensive facilities, auxiliary plants, and local infrastructure.

48. Planners design and organize industries along structural lines suitable for introduction in developing countries and regions. Planners ascertain a region's industry composition or industrial potential and study the products (and output

4/ An optimum size production unit is one that obtains the lowest unit cost of output in a given state of technology. A minimum economic size facility or multiple-plant unit is that scale beyond which long-run unit cost begins to decline slowly over a wide range of output (especially in the field of manufacturing).

The scale of the minimum economic size unit depends on the output volume of the largest (in output rate) high-productivity, capital-intensive equipment or integrated processing unit; the scale of the minimum economic size industrial complex depends on the capacity of the largest (in output rate) economic size constituent plant. Analysts identify the minimum economic size divisional unit of an industry as that output volume which fully employs (at rated capacity) the high-productivity constituent indivisible equipment or facility, which may be a high-speed machine, an integrated fabrication line or assembly line, or an expensive auxiliary plant.

5/ Rated capacity (the effective output capability) is the output attainable when a plant or an entire industry operates on the basis of the standard or customary length of week and number shifts (e.g. single shift, 48-hour week) with an allowance for normal delays - i.e., shutdowns resulting from machine failure and equipment repair or renewal, job setups and changeovers, processing difficulties, absenteeism, and the like. Rated capacity is computed from past performance, trial runs, or engineering data. Managers would tend to adopt a multiple-shift production intensity when investment in plant is high and unit cost (as well as the initial investment outlay) can be lowered through multiple-shift operation.

targets) selected for production. They would group products for process relatedness, material relatedness, market relatedness, and infrastructure requirements. Assembled final products would be further broken down into common components and sub-assembly units.

49. Industrial planners, then, promote the maximum adoption of common components (standard interchangeable sub-assemblies, parts, and supply items) that are selected or designed to go into the fabrication and assembly of similar as well as different kinds of products. For economical and accelerated industrialization, developing regions can adopt a scientific, broad-based product-design approach (essentially, a broad approach for the selection of sub-assembly units and parts) which permits large-scale output of standard sub-assemblies and parts by specialised plants for absorption into the assembly of a wide range of final products.

50. In this approach, products (including sub-assemblies and parts) that require the same or similar production technology are grouped to make up a process-related product line for joint output (usually output on an intermittant basis) by a given plant or industrial complex. The process-related product line approach for designing and setting up plants or complexes is employed where the projected output volume (the projected market) of a product or item is not sufficient for the erection of a minimum economic size production unit.

51. Where resources and other location requirements are favourable or, at least, permissive, planners would specify plants and industrial complexes on the basis of process-related product lines so as to obtain ("carve out") a larger volume of the same or similar production requirement for low-cost output by a minimum economic size production unit. Diverse items of small volume requirements would be grouped to make up broader process-related product lines for economic output by more adaptable (less specialized) facilities.

52. Analysts may break down a product line slated for large volume output into two (or more) narrower process-related product lines for efficient output by more specialized industrial complexes or plants. Large optimum-size industrial complexes sometimes may be split up, without any appreciable sacrifice of productivity, into two or more divisions of a minimum economic size so as to obtain a wider locational dispersal of industries and build up specialized industrial districts in different areas. In the long-term process of progressive division of labour, more specialized plants and industrial complexes would continually gestate and spawn in the industrial environment.

53. Depending on the particular dispersal of consuming industries and consumer market areas, market-oriented complexes would locate in areas of relatively high-income potential; such areas may include urban areas, major transport centres, areas of intensive agriculture, richly-endowed lake areas, larger valleys and basins, and harbour areas. Planners would set up or promote, in selected growth areas, the emergence of one or more appropriately-specialized production centres or districts consisting of a well-situated cluster of industrial plants or complexes that employ more or less the same or similar production technology, materials, and infrastructure. These centres would include material-oriented plants and complexes, market-oriented complexes and single plants, auxiliary facilities, and infrastructure facilities.

54. In striving for an economically "ideal" geographic specialization of industries, planners, in their long-term analytic procedure, project the kind of specialized production centre that is best suited to each area and region in the long run, including the economic exploitation of a continental or sub-continental infrastructure system (particularly the economic utilization of continental transport and power systems). The entire infrastructure includes road transport, railways, air transport, power supply, water supply, and waste-disposal facilities.

55. Basically, the emerging industry-location pattern is perspective or "indicative" physical planning. It serves as a basis for preparing economically viable five-year or "short-term" plans consisting of projects for erecting vertical segments of capacity and techno-economically related facilities, including companion infrastructure. (A later section deals with relevant economic planning and programming aspects, particularly with respect to the provision of infrastructure.)

The efficiency of geographically-specialized industrial complexes

56. Through regional analysis and the sequential and mutual locating of industrial plants and economic activities, planners develop a projected geographic-specialization-of-industry location pattern for planning and programming regional industrialization, infrastructure development, and accelerated economic growth. As compared to dispersed and isolated enterprises, geographically specialized industries and industrial complexes require smaller investment for their development, are more adaptable, and operate at substantially higher productivity.

57. More precisely, economic development along the lines of a predetermined geographic specialization of industries achieves productivity gains and advantages in a number of ways: It specifies the types of skills required for each projected specialized production centre or industrial district and, thereby, provides time for the provision of a pool of skilled labour in advance of long-term requirements; it obtains lower transportation costs; it calls for a smaller investment in inventory stocks (obtains a more optimal stock-sales ratio); it promotes more stable levels of production and utilization of plant capacity; it promotes industry-wide adoption of mass-production methods of output; it requires a smaller capital outlay for the erection of plant capacity or for the revision and modernization of plant; it promotes the emergence of industrial research and a flow of technological innovations; it promotes the emergence of service and ancillary plants and a supply of components to producers; it specifies appropriate special-purpose (more efficient) types of infrastructure, providing ample time for engineering and erection of infrastructure synchronized for emergence with the establishment of industries in a given area, and attains more intensive long-term utilization of infrastructure. The foregoing advantages of economic development along the lines of a projected geographic specialization of production are amplified below.

58. A production centre comprised of enterprises specializing in techno-economically similar lines of business (whether in extractive, manufacturing, or service lines of industries) creates a labour pool of skilled and technical labour. Geographically specialized industries may augment the supply of skilled labour by an early inauguration of trade and technical schools. By pre-determining the location of industries well in advance of their erection, planners, however, obtain time in which to attempt to establish technical schools for the provision of the required skilled and professional personnel, so that the "labour bottleneck" need not emerge to retard industrial development or adversely influence location decisions. The provision of the required skills in advance of demand creates a desired "labour pull" on industries to draw them to their economically valid locations. The general availability of somewhat better-schooled labour in existing urban areas would, however, tend to attract and accelerate the establishment of certain labour-intensive industries. Such labour-oriented industries would consist of establishments in which labour costs make up a significant share of the unit cost of output, business volume tends to fluctuate, and the ease of selecting and recruiting effective workers from a large local supply facilitates the maintenance of a relatively efficient work force. Furthermore, industries requiring skilled personnel tend to be drawn to urban areas where such manpower is usually concentrated.

59. A predetermined geographic specialization of industries obtains a more economical pattern of transportation; it eliminates needless movement of cargo and minimizes the cross hauling of cargo and the multiplicity of shipments. The location of establishments, industrial complexes, and specialized production centres on the basis of a long-range transport design and long-term transportation costs obtains the economical shipping of finished goods and economical inbound movement of raw materials that a modern transport technology can provide.

60. The design and timely programming for the provision of transport (as in the case of power and other infrastructure) for a constellation of related specialized industrial districts promotes an intensive utilization of such infrastructure and lower cost transport services.6/ The localization of industries in specialized production centres obtains lower industry-wide stock-sales ratios. This quantitative shrinkage in inventory stocks, and resulting lower investment in inventories, is appreciable in the many industries that produce high-value goods, wherein investment in stock tends to exceed investment in plant and equipment. The localization of industries obtains lower finished stock levels because quicker delivery and shorter distribution channels absorb less stock.

61. Rationalized plants and industrial complexes in well-situated industrial districts obtain markedly low stock-sales ratios owing to the greater integration of plants and wider absorption of interchangeable subassemblies and components in the assembly of final products. Industrial rationalization shrinks inventory stocks by designing plants for adaptability to changes in the product mix, by shortening distribution channels, and by obtaining more efficient materials-handling and transport arrangements. Industrial rationalization also obtains economies by promoting the adoption of improved inventory control systems and hand-to-mouth purchasing practices.

62. Producers situated in a specialized production district can more effectively adapt facilities and operations to changes in products, product mix, and production requirements because of a wider range of equipment types and sizes available for current and standby operations. Producers can also attain a more stable volume of output in the face of seasonal influences and shifts in market demand owing to the greater availability of market information and more effective forecasting, and to the greater opportunity for purchases from local subcontractors to meet peak-sales

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6/ The analysis and the approach for attaining this economic arrangement is allocated to a later section.

requirements or for engaging in subcontracting work during the slack season. Producers, moreover, experience fewer production interruptions because of a more reliable supply of materials, utilities, repairs and facilities.

63. The geographic concentration of producers in similar lines of business readily and economically promotes the emergence of industrial research. The concentrated location pattern is more conducive to the assembly of a community of technicians, engineers, and scientists and to the establishment of industry-wide and publicly-aided research activity for the generation of a flow of technological innovations specifically geared to the needs of the industry.

64. A concentration of more or less specialized production in an economically favourable location reaps productivity gains from lower-priced inputs of productive factors in terms of goods and services (that is, from external economies), as well as from the broader adoption by economic-size establishments of mass-production technology (that is, from internal economies). Specialized ancillary plants emerge to supply sub-assemblies and parts to producers of different though technically related products. A large market, comprised of techno-economically related producers in the general area, promotes the emergence of specialized enterprises that offer such services as equipment repair, motor trucking, warehousing, plant construction, waste disposal, engineering, technical education, and other local infrastructure services.

65. Producers locating in an economically compatible centre of specialization obtain lower operating costs (lower break-even points) owing to the availability of skilled labour and specialized suppliers and to the procurement of lower-priced materials and utilities. Lower production costs permit the quoting of lower prices and, generally, a larger volume of sales for many lines of goods which, in turn and in the long run, promotes wider utilization of mass-production (high-speed) machinery that obtains lower fixed costs and lower labour cost per unit of output.

66. Thus, when a plant or an industrial complex, designed for the output of a process-related product line, is located in a specialized industrial district, it obtains a low break-even point from external economies (including savings from purchases of low-priced sub-assemblies and components) and from internal economies, though in some cases internal economies may be somewhat limited in the initial years of business. As earlier indicated, through the joint output of related goods, an enterprise obtains internal economies from a relatively high utilization of capacity. Since a rationalized minimum economic size enterprise, when situated in

a specialized production centre, enjoys a lower break-even point, it would be an economically viable enterprise even though it might be somewhat under-utilized. 1/

II INFRASTRUCTURE PROVISION FOR REGIONAL INDUSTRIAL COMPLEXES

67. Infrastructure provides the basic services to industry necessary to the production process. These "economic overhead" services include transportation, power and water supply, and communication. Social infrastructure consists of education, health, and the various public services that contribute to economic growth and the increase in productivity generally.

68. The provision of such infrastructure as highways, railways, terminals and power facilities absorb large amounts of capital. The capital intensiveness and capital "lumpiness" of infrastructure derives from the geographic dispersal of the demand and market for their services and the physical extensiveness of their facilities.

69. The programming of geographically-scattered development projects often means that newly erected plants are provided with either high-cost, under-utilized infrastructure services, or are handicapped by interruptions stemming from bottlenecks in transportation and power. Poorly planned and indiscriminate infrastructure erection results not only in under-utilized capacity, but in long-term economic dislocations due to the pulling of plants to areas and sites by the short-term availability to transport or power, rather than plants being rationally located on the basis of the best available resource and market situations. A development approach which permits heavy absorption of investment in under-utilized infrastructure, moreover, retards the rate of economic growth because it represents misdirected development and a waste of resources.

1/ A rationalization programme (as earlier outlined) standardizes materials and sub-assemblies and maximizes their interchangeability for the assembly or fabrication into various final products. It organizes industrial complexes of minimum economic size on the basis of process-related product lines designed for appropriate adaptability and integration and for intensive use of infrastructure and other productivity gains; it sets up specialized production centres consisting of techno-economically related industrial complexes and plants; and it locates these centres for economical production and distribution and for complementary interrelationship with neighbouring production districts, i.e., on the basis of a spectrum of industrial technology.

70. Because of the general indivisible nature of infrastructure and the fact that facilities are often built ahead of demand, under-utilization of facilities (excess capacity) is considered to be unavoidable. This means that for a period of years, large investments for economic development contribute little to the supply of goods and services.

71. Balanced programming seeks to avoid the needless excess capacity above that which is inherent in the indivisibility of the facilities. Capital lumpiness and under-utilization can obviously be somewhat reduced by the practice of tailoring and staging the construction of highways, thermal power plants, and coastal shipping, to fit the current requirements of industry and development. Such balanced programming attempts provide sufficient infrastructure services to prevent the emergence of production bottlenecks as new industrial facilities go into operation.

72. Planners must try to provide for adequate infrastructure so that industry can function without shortages in power, transportation, and communication. Shortages result in curtailment of production, under-utilisation of plant-capacity, and excess accumulation and hoarding of raw-material stocks. Planners must, however, avoid the erection of technically "over-specified" facilities and erection of excess capacity (under-utilized facilities) in infrastructure, and the consequent high service charges.

73. Planners, too, must provide developing countries with technically and economically efficient and useful types of infrastructure for long-term needs and rational economic development. That is, they must avoid the incidence of premature obsolescence in capital-intensive facilities (both in design and economic utility). The infrastructure must meet the needs of long-term economic development and provide a useful service for a long span of years.

74. Transport and power supply are integral parts of industrial and economic activity. Effective industrial planning depends on a continual survey of resources and their evaluation for commercial exploitation on the basis of richness and accessibility in terms of projected transport and power technology. A transport study must derive from studies of resources and plans for agricultural development and industrialization. Economic objectives and development plans must obviously be translated into transportation requirements, if an efficient long-term transport system is to be designed and developed.

75. The projected cost of transport services influences the location of industries and the kinds of industrial complexes that can be established. An economical

transport system and an inter-connected power system enlarge the scope of markets and open up "growth areas" for situating specialized production centres. Because of the larger number of available location options, industrial complexes can be more advantageously situated for cheaper inputs and efficient production.

76. It is essentially by projecting a geographic specialization of economic activities that planners specify the long-term rational direction of development and the industries economically valid for each area. A continuing study for the projection and refinement of a location pattern for industries obtains an efficient distribution of specialized production activities. A location study essentially allocates and situates related industrial activities and land uses to areas and districts where specific economic activities would be advantageously sited; and where the required plants can be organized and arranged for efficient use of land as well as for efficient production.

77. Pre-determined regional location of industry serves as a means for identifying, acquiring, and reserving scarce well-situated industrial land for vital long-term economic development. It, thereby, determines the best use for scarce industrial land and provides the time necessary for research and thorough planning of the economic aspects that facilitate town planning. In the short run, industrial land may be effectively employed for agriculture, storage areas, public markets, open-air cinemas, rather than for permanent structures.

78. By projecting the kind and the size of industries suited to each economic area (by projecting economic potential), planners determine the infrastructure specification for each area in terms of transportation, power, water, waste disposal, communication, technical education, medical facilities and the like. A projected location of mining, iron and steel, and basic chemicals industries, for instance, indicates where heavy transport services and power would be required.

79. A location-projection survey shortens the gestation time for erecting and establishing industries and infrastructure because it enables advanced long-term decision making and, thus, provides ample time for thorough economic and engineering studies and for selection and acquisition of industrial sites.

80. The planning of transportation, communication, power, and water-supply systems is fundamentally based on a projected economic and industrial geography of a developing region. The projection, to be sure, undergoes adaptation and refinement to accommodate technological innovations and the availability of more complete resource data.

81. A projected economic geography enables planners to determine the routes and kinds of transport services required, areas of water surplus and areas of water demand, areas of cheap fuel and power surplus, and the pattern and stages for the evolution of an interconnected power grid. Planners, for instance, would estimate the types, volume, and seasonality in the flow of cargo so that they could evolve a rational transport system.

82. It is on the basis of over-all analysis and the emerging transport technology that the planner projects economic development and designates the transport media that are economically suitable for the various types of cargo and branches of industry. The cost and performance of the various transport services differs among areas because of the differences in the types and volume of goods that move and differences in geographic location of industries.

83. The development of a transport system takes into account the trend in transport technology, comparative transport capabilities and costs for different transport media, the impact of different transport media on production and distribution costs, and the net long-term effect on economic development of the various transport media. The media selected would be based on comparative costs, not only in terms of the transportation service, but on the total long-run cost (the future cost) of production and distribution for industries projected for development. The projected freight cargo to be moved, therefore, would be allocated among different transport media so as to attain minimum long-term investment in both transport and industry and to obtain accelerated economic growth.

84. Planners develop a transport system on the basis of topography, geographic configuration of economic areas, and a projected flow of goods from industries and areas planned for development. Planners select general routes for surface and water transport and stipulate terminal and key intermediate points. (The development of a cargo air transport system and air transport-based industries is outlined in a later section.)

85. Transportation analysts select the type of carriers (type of transport services) on the basis of development strategy, adaptability, and long-term costs for moving designated types of freight in the projected economy. The specification of transport services involves the stipulation and allocation of transport media among freight and passenger services, for long-haul and short-haul trips, for bulk and small package goods movement, for high-value and low-value cargo, and so on.[8/]

8/ In general, long hauls in heavy traffic would be allocated to railways and water carriers; road transport finds its best use for moving high value goods and perishables over short hauls; and air transport is economical for high value products relative to their bulk.

86. A detailed study of projected economic development and of transport requirements provides the specifications for final routes, initially the routes for areas selected for earlier programming of development. The construction of transportation is programmed for effective synchronization with the progress of plant construction for industrialization and projects for agricultural development.

87. Planners should take into account relevant technological trends in the projection of transport, and industrial potentialities. They should particularly note the progress in miniaturization of both consumer and producer goods. Light-engineering and electrical industries, for instance, devote a large share of their capacity to the output of goods of high value relative to their bulk (small high-value products). This means that a substantial share of the manufactured products of the immediate future will be goods of high unit value relative to their bulk.9/ Meanwhile, the continual long-term drop in the cost of air-cargo shipping means that air transport will expand secularly. A decision for the future introduction of air transport services for a given industry in developing regions should take into account the important savings in inventory that would take place, the over-all reduction in inventory carrying charges, and the advantage of speed in transport of materials.

88. Industries operating on the basis of air transport can, therefore, obtain substantial economies in terms of steadier production, short distribution channels, speed in adjusting to changes in market demand, and low over-all inventory levels. The foregoing economies, and the possibilities of establishing efficient industrial complexes of minimum economic size, create the economic conditions for a measure of industrial development on the basis of air transport in the years ahead.10/

9/ Miniaturised sub-assembly units and components go into the assembly of business machines, automobile control devices, air conditioners, television sets and radios, and a growing group of other products. Air-shipped subassembly units and components that also go into the final assembly of many products include transmissions, clutches, gears, crankshafts, axles, instruments, pumps and control devices, generators, motors, rubber and plastic parts, and the like.

10/ Most fundamental is the fact that air transport might become a major means for overcoming the obstacle of small markets. A continental constellation of inter-related industrial complexes and specialized production districts might emerge to produce and distribute to an enormous market and thereby obtain a balanced flow of freight and intensive utilization of air transport facilities that will make for low shipping costs and lower-priced inputs.

89. The investment required for the provision of cargo air-transport services would be comparatively low because of the general excess capacity in airline facilities in developing countries. Moreover, cargo aircraft would be acquired singly as needed.[11/] The comparative absence of capital lumpiness in cargo air-transport facilities would enable a gradual expansion in airfreight carrying capacity.

Interrelationships in the programming of infrastructure and industry

90. Perspective planning projects the future industrial geography of a developing country by outlining its constituent economic areas, location pattern for industries, and a flow of economic activities. Such planning provides a large backlog of viable industrial and agricultural projects that make it possible for planners to prepare and maintain an up-to-date, long-range development plan for years ahead. Since perspective planning provides a wide range of viable projects for the erection of industries and infrastructure, it offers alternative directions and approaches for economic growth. In order that they may determine the most effective strategy for economic growth, planners analyze the perspective projection (a projection of the geographic specialization of industry two decades or more ahead) to ascertain and evaluate alternative directions and approaches for developing the earlier stage of economic growth and the ultimate growth of the economy as a whole.

91. Although there are many intricate aspects to the problem, the selection of an economically valid growth strategy is crucial to success. Stated in simple terms, planners employ the perspective plan as a basis for following through alternative paths for economic development (alternative approaches and sequences for developing industry branches, infrastructure, agriculture, etc.) and for appraising the results of each in terms of such criteria as the rate of growth, attainment of technological proficiency, investment absorption, and ease of maintaining economic balance, that is, avoiding imbalances in capacity, in the balance of payments, and in inflationary forces.

92. Once a valid growth strategy is determined, planners implement the strategy by preparing an economic plan for programming the establishment of specified industries and infrastructure in selected areas in conformity with the predetermined industry-location pattern.

11/ Aircraft builders would likely find it economical to tailor their aircraft designs for developing countries. For instance, slower planes would be appropriate because of the substantial differential between air speed and that of surface speed.

93. When they are nurtured by perspective planning, planners are able to prepare and implement a succession of comparatively long-range plans (six to ten years) for developing industries, infrastructure, agriculture, education, and other cultural improvements. Such "planning in depth" is particularly vital for programming infrastructure and industry for concurrent completion and for obtaining the necessary adaptability in programming essential for minimizing the emergence of imbalances in the process of growth.

94. On the basis of a projected industrial geography, planning and programming can accelerate regional development by initially exploiting the economic potential of the most promising areas and growth points. These would include major urban areas as well as selected regions in the accessible and favourably located resource endowments of rich mineral deposits such as copper, bauxite, and potash; timber resources for lumber and pulp industries; and rich sources of fuel (coal, oil, sites for hydro-electric power). Industrial programming would initially concentrate on those capital-intensive industrial projects that promote the emergence of scale economies and step up economic expansion.

95. Planners introduce geographically specialized industries and integrate an emerging economy by programming a succession of techno-economically related vertical segments of capacity in line with the predetermined industry-location pattern, within the limits of available investment funds and short-term supply of skilled and professional labour.[12/]

96. The programming of a new industry usually involves the erection of vertically-related plants and industrial complexes at pre-located industrial districts. This vertical segment of capacity would generally consist of early, intermediate and final-stage plant capacity and the supporting specialized local infrastructure. The constituent plants and industrial complexes would be mutually supporting in that they would be comprised of supplying establishments and consuming establishments.

97. Planners programme the expansion of an existing line of production by enlarging output capacity all along the line of a vertical segment of productive facilities and the specialized local infrastructure facilities. This may involve

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12/ It is obvious that short-term planning for economic growth in developing countries involves many obstacles - political instability, trade imbalances, inflation, shortage of capital and skilled labour, etc. This paper limits its coverage to the outlined long-range location-and-development approach and its contribution to facilitating long-term economic development on a more rational basis.

the erection of a duplicate early-stage plant and an enlargement of a final-stage industrial complex. It may, however, call for the erection of a more specialized final-stage industrial complex (or plant) and the conversion of an existing industrial complex (or plant) to a narrower line of production. Programming, in this instance, splits a line of production and allocates a narrower line of work to more specialized establishments.

98. The development plan would typically include the programming of a number of groups of techno-economically related single establishments pre-planned for location in appropriate specialized production centres. In the earlier stage of economic development, many of these establishments are designed to put out products substituting for imported goods. Since the foregoing plants were largely selected on the basis of their material relatedness, the specified early-stage plants would be erected with a ready market for their output.

99. A long-range approach to economic growth enables planners to prepare plans and programmes that take into account detailed infrastructure needs (depots, terminals, warehousing, special handling facilities) of industries pre-located at various growth districts and areas. Such an approach enables planners to avoid, or, at least, to minimize the waste of resources stemming from economic imbalances that consist of shortages in capacity (or output) in certain industries and infrastructure along with excess (under-utilized) capacity in other industry branches and infrastructure.

100. The attainment of integrated industrial development necessitates advanced programming of transport and power facilities so as to assure the provision of the infrastructure services required for industries scheduled for early emergence. Long-range planning in depth on the basis of a predetermined industry-location pattern enables planners to identify the transport and power infrastructure involving long gestation for its erection.

101. Long-range programming would then specify the needed transport routes and facilities and the time schedule for their erection. Such programming erects those sections of the pre-planned transport system required for synchronized emergence with particular industries.

102. Planners may specify a transitional scheme for the provision of transport services. A near-term scheme for the provision of transport for a given route may stipulate motor trucking or a narrow-gauge railway which is later to be replaced

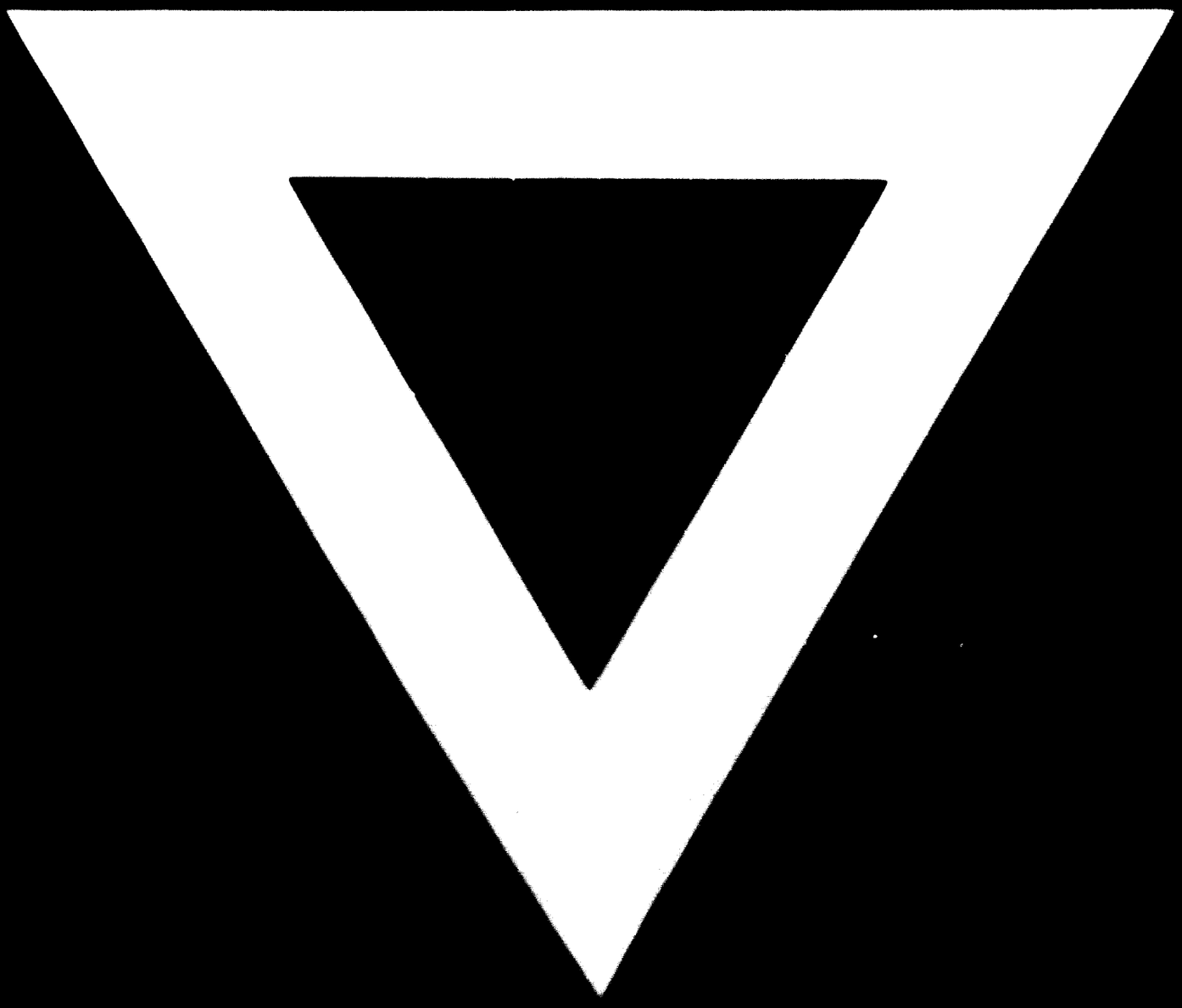
by a standard gauge railway line. The dismantled narrow-gauge railway may be installed for local infrastructure of isolated industrial districts.

103. Planners would not long delay the improvement or the linking up of transport services between neighbouring economic areas. The programming of complementary industrial enterprises at neighbouring economic areas obtains a more intensive use of linking transport services. Transport utilization is augmented by an early programming and construction of industrial establishments situated at major cross-roads and along the environs of the main route between economic areas.

104. The long-range development plan takes into account the cost of power. A study for long-term power supply analyzes the long-range development plan and formulates the most rational scheme for acquiring an economical long-term power supply, while satisfying near-term power requirements with a minimum of under-utilized capacity. The long-term supply (and cost) of power would depend on the feasibility of designing suitable stages for evolving an interconnected power system. The near-term supply (and cost) of power would depend on the relative cost of fuel sources, availability of hydro-electric power sites, and the types of power stations that can be economically erected to meet the near-term demand for power as indicated by the development plan.

105. In the short run, certain isolated production centres can be supplied by a local power station. Small power stations may be equipped with a transportable-type turbine which can later be installed in another area. As the demand for power increases, the spreading power network supplies electricity to formerly isolated production centres.

106. Planners essentially achieve industrial development at low investment in plant and infrastructure by programming industrial capacity for the emergence of a number of integrated industrial districts. By expanding (filling in) capacity in a constellation of related production centres in line with a predetermined geographical specialization of industry, planners obtain intensive use of power and transport facilities, lower stock-sales ratios and other economies of scale.



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