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Workshop on Creation and Transfer
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CHALLENGES TO THE CREATION AND TRANSFER OF KNOW-HOW 1/

by

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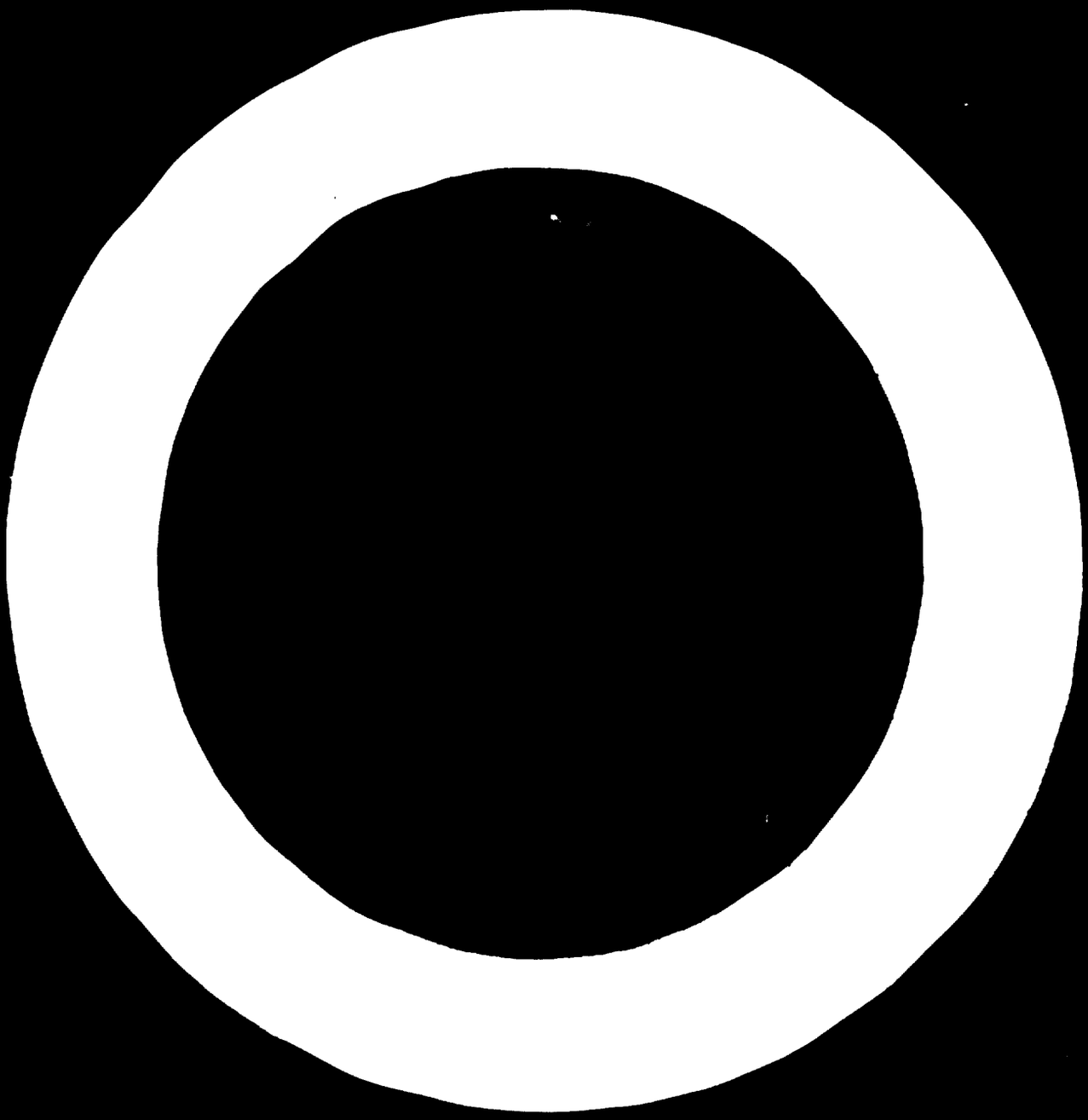

1. The ever-shrinking nature of the world we live in emphasizes the realization of the vast differences between the "have" and "have not" nations. Most developing countries manage to increase their G.N.P. about two to five per cent per year, but from this must be deducted a population growth of two to three percent. This is not nearly enough. Dynamic changes are required.

2. Half of the world's population lives in developing countries. Almost half of the known deposits of iron ore are found in these countries and over 20% of the world's total is mined in these countries. They own about half of the world's natural gas and 85% of the oil, but they produce only about 4% of the world's steel output.

3. It is essential that the poorer nations develop their economies, increase their output and wealth, and improve the lot of their citizens. If then, the L.D.C.'s are to "take off" economically, they must work out mutually acceptable arrangements with those having resources in capital, organization, and experienced man power.

4. Technological expansion has become a prime objective of the developing nations for bettering their internal economies and achieving participation in the advantages potentially available from their natural resources. Technical and industrial progress cannot be isolated. It cannot be restricted to those nations having technical facilities and experience. Aid from other countries and international bodies is important. It would be a major tragedy for both the poor and the wealthy countries if it were not forthcoming. The manner in which such essential know-how can be imparted is the subject of this work shop, and while it is limited to "metallurgical", any of the problems discussed, any of the answers obtained, will certainly apply to all industry.

Customer Consultant Relationship

5. Private organizations and companies in the industrialized and technically sophisticated countries have, through their own efforts, become prime sources for the realization of technical and industrial development. The individual essential services such companies provide

have become integrated into what we recognize today as engineering/consulting/contracting companies. These companies provide a high level team in which we find a concentration of individual skills, experience, and adeptness. They furnish the required demands for the physical realization of an industrial complex, including research and development, process, detail engineering, erection, initial operation, management services for the actual administration and operation, and have for the most part, been the principle source of dispensing know-how.

6. The international consultant must be a bit of a "con" man. Often his toughest job is gaining the confidence of his customer, and the most important requirement of a successful project is mutual confidence between the consultant and his client. The buyer and seller of technical services must each understand the intent and objectives of the other. The consultant assumes the obligation in his transaction with the client to help him and guide him within the limits which may be dictated, so that the client can attain his objective to function and operate in the manner which satisfies his interests. The consultant must understand the nature of the project in its broader context-economic, political, social, cultural, within which he functions. Efficiency in purely the technical sense is not enough. He must recognize that his ethical responsibility is a genuine one and he must understand that a double standard of professional ethics, one for his country and the other for international is unacceptable. He must not make promises he cannot tactfully fulfill.

7. For the customer's part, he must award his confidence to the practitioners having the skills and integrity they claim. The decision must be made on the technical ability, international experience, integrity and brain power of the group. He must understand that the consultant is entitled to, and must achieve an equitable profit. Within the context of this philosophy, a mutual understanding must generate to permit each party to benefit from the transaction.

Joint Responsibility

8. Undoubtedly, an influence is brought to bear by the degree of

development of the specific nation or client, and in the disseminating of information the consultant's responsibility changes from country to country. The less sophisticated a nation is technically, the greater the responsibility of the engineer. This is but an enlargement on the precept in our own country as to the engineer's responsibility in regards to the knowledge of his native clients. Many countries have an increasing number of highly educated and dedicated professionals eager to serve in their field. Others, of course, may have very few, making the responsibility greater, and the training program more difficult. The nature of technology brings into focus the growing need for highly specialized client personnel. Such is the client's need to enable him first, to evaluate processes and operations, and later to maintain and operate his installed facilities, so that the investment he has made can fulfill its promise and be economically amortized. This expertise, more often than not in developing areas, must be furnished by the consultant.

Feasibility

9. Considerable effort must be directed to the determination of the processing sequences which would best serve the intended purposes, i.e. the feasibility study. Here the experience and constructive information of the engineer attains the utmost importance in being able to originate, develop and assist the client. It is all too easy to overlook the extensive amount of data, people, talent, and experience that enter into a decision to build a plant. Too often we find that the implementation of the project in establishing its feasibility and securing its funds, is undertaken by those not properly equipped to carry it out in the most fruitful fashion. This is not peculiar to business in developing countries but has also been experienced by established businesses in the industrialized countries.

10. Project development begins as the first gleam in the client's eye and carries through to the final success in securing the requisite financing. The feasibility studies must:

1. Determine the economic feasibility.
2. Establish practical technical concept.
3. Assist in the completion of the financing.

Defining the Project

11. Justifying the project from a financial point of view is a multi-faceted effort. The availability of raw materials must be established; the problems associated with producing the products best suited to the needs of the country must be assessed; a market evaluation must be made to determine the product demands. With such basic information, the engineer can further develop his practical concept of the project, ascertaining the optimum manufacturing approach to make the products previously determined as required.

12. All such information must then be translated into estimates of capital investment and operating costs to determine the comparative profitabilities of the various sequences of operation which may be under study. The development phase is a cooperative effort on the part of the engineer and the client, utilizing the experience of the engineer to the maximum extent in bringing the contemplated project into clear focus. In essence, the engineer in this context serves to increase the overall effectiveness of the financial aid which may be extended to the specific country or client and by so doing enhances the nations economic development. The practical result is an aid to the client nation in achieving a greater degree of technical and economic sophistication and self-sufficiency, and it is in this area that know-how is the weakest in the developing country; and consequently, where the greatest care must be used in the selection of the consultant.

13. As the project moves forward, the engineer is increasingly able to call upon the resources of the client and the country involved, ever aware of his responsibility to utilize to the greatest practicable extent the indigenous resources in terms of men, skills, capital and local industry. It is in the best interests of the client to use local resources whenever possible, so that they be maintained and developed to the benefit of his and his country's economy.

14. The preceding comments are certainly not new. Most of them have been presented before groups such as this before. Any consultant worth his salt will verify market, source of raw materials, transportation, etc. Where then are the dangers of misapplication. The answer can probably best be summed up in "human nature".

Project Size

15. The situation in the world market for iron and steel products is one of over capacity with fierce competition and a depressed price level. Yet the tendency all too often is to build on too large a scale, economically justified by planning for export. Export to whom? A large scale, specialized plant, based on most advanced techniques not operating to capacity, results in underutilization of capital. The standards of quality control, the scheduling complexities and transportation difficulties involved are beyond the organizational skills and capabilities which are available. With these handicaps the developing country cannot hope to compete for export. This trend towards using and developing equipment of large capacity which has led industrialized countries to the creation of large integrated plants, serving large markets, has been in some cases a barrier to establishing a metallurgical industry in developing countries. In one case a country with the necessary raw materials, a market, but with no iron or steel production and desirous of such an industry, had a study made which proved very feasible, enabling the owners to make a good profit. This project was abandoned because the financial backers felt it was neither large enough nor modern enough. Another study, based upon desires, greatly increased the costs and the project no longer proved feasible. Ten years later the country still has no steel production facilities.

16. Size, process, and moderness must be determined by judgement, not wishes. Large scale, fully integrated iron and steel plants are economically advantageous in the industrialized areas with large markets. In the developing countries, with shortage of capital and a limited market, smaller plants may be established which can operate economically, produce at prices competitive with imports and not requiring foreign exchange and at the same time provide a reasonable return on capital.

17. Even the industrialized countries are now looking towards the smaller capacity mills. Technology has provided the possibility of the integrated plant without the necessity of the coke ovens and the blast furnaces. Where adequate capital and resources including labor are not available for installing a so called "conventional" plant, it is possible to integrate vertically, and ultimately having an electric furnace, continuous casting combination fed by sponge iron.

18. Many countries object to playing the part of what they term "quarry", where they ship their natural resources in the form of ore to a foreign country without any processing. They are correct in being concerned and objecting. These countries might well consider their integration of a steel industry by starting with the beneficiating and pelletizing of their ores before shipping. This would certainly be a start towards processing.

19. Engineering principles, while universally applicable, become, when applied to a developing country, a matter of scaling down. The physical plants and production methods which have been designed for the developed countries on the basis of labor saving high production, if transferred to a developing country, results in exaggerating the capital requirement per unit of output. The thinking must change to a labor-using, capital-saving technique.

20. All this does not mean the planners must not think big. Planning should not be limited to 5 - 10 years ahead, but at least a generation and more, and the initial installation should be able to fit into this look into the future. Site must be ample for this long range plan. Likewise it does not mean extreme labor using devices are to be utilized.

21. The problem of maintaining the proper balance between capital of high value and labor of low value as found in a developing country is most difficult to solve, but we cannot evade the problem by simply transferring the technology from a capital-intensive, labor saving developed country.

Equipment Selection

22. Used equipment should certainly be used in some cases when available.

In an industrialized country, changes in technology, changas in product demands may affect tha usefulness of tha axisting equipment, making it obsoleacent. Because of e rise in labor costa more automated equipment may be required. In all of these cases obsolescent does not mean worn out, and the equipment may raprasent a considarable advance in tha daveloping country et a great savings of capital. Even if the quality of tha ateel did not compare with that which could be produced by the replacement equipment, it would probably not present a sarious problem. It is normally felt that quality requirements in developing nations need not be as stringent as thoae in tha developad nations as the applications of the steel ara usually simpler. Unfortunately, the consultant who tries to convince his customer, in a less developed country, that the proper aquipment to buy is something which in the more devaloped world ia considered obsolete, has a most difficult task.

23. Along with edapting size and procass to the developing country, the angineer must exart ingenuity and resourcafulness in tha proper detail design of the equipment to be furnished. Consideretion must be given to tha climate, operator's skill, replacement, etc. Ha must think in terms of a technology which is appropriate for tha poorar countrias. High tensile steel should be eliminated. If it braaks it may take six months for a replacement, so make the item heavier with common ateel. Can weldments be used inataad of forgings? Electric motors are usually subjacted to greater voltage regulations. Eliminate dimensions ao tight that only a modern factory, with million dollar machine tools and skilled apecialists or numerically controlled machines can provide them. Use stendard parts instead of special onas. Remember, if it movee it will wear out, and if it doesn't move it will break anyway. Can it be dasigned for self-protection against abusa and neglect? A particular alectronic gadget may look elegent and save lots of labor, but it is hell for the man who will have to fix it, or for the plant operation if weeks are raquirad to replace it. A wheel barrow working is much better than an automated conveyor that is not. This might be called "Model T Design" named aftar Mr. Ford's first mass produced automobile, but it trained millions of U.S. mechanics. As a child thare was a song I

remember which in part said, "patch it up with a piece of string, chewing gum, or any old thing". This did not repair it to its original condition, but it did permit it to continue to operate.

24. At the same time great care must be given to the spare parts list. They may not be the same as used in the developed country, and remember, the customer cannot afford a duplicate of the equipment in spares. The maintenance manuals must be much more complete and clear in all respects. Lots of pictures and exploded diagrams will help. Make sure this is ready to go with the first shipment of equipment and that everything is included, even the obvious.

The Market Place

25. It has commonly been said that the most important factors in establishing an iron and steel industry are:

1. Availability of Raw Materials
2. Market
3. Capital

At one time it was believed the largest single factor was the availability of raw materials. Assuming the necessary capital and utilities are available, including transportation, the largest single factor is market. It is generally proved now that it is possible to operate economically, having hardly any domestic raw material resources as long as the volume of demand is present.

26. The dangers of an underdeveloped country starting a steel industry have already been pointed out, which presents the problem of the local market. The most common method of identifying a less developed economy is by the low level of its annual per capita income. Also, such statistics as are available confirm the general impression that the distribution of that average income is more unequal in the less developed countries. Mass production is not possible without mass consumption. With the percentage of increase in G.N.P. increasing at a lesser or even nearly the same rate as the percentage of increase in population, we are presented with the difficult problem of reversing this vicious circle.

Efforts to raise real incomes can be classified according to augmenting the productive resources available, raising the level of the technology employed, improving the social cultural environment within which the effort takes place.

27. It has fallen upon the shoulders of industry to be the leading growth sector of the economy both in raising output and increasing employment. In fact, it was pointed out at the United Nations Interregional Symposium in Prague, 1963, that there is no example of sustained economic growth in a country without a corresponding increase in steel production, and with few exceptions there was no case of high standards of living existing without a developed steel industry.

28. The financial resources in less developed countries are grossly inadequate, and their one real source of wealth is the immense potential of labor. This potential can be categorized as non-monetized capital, but conversely it must be remembered that this same surplus, unless utilized, is contributing nothing to output and is decreasing the per capita income.

29. The steel industry fulfills the requirements for utilizing this human capital and at the same time produces an output which is of great need to the developing countries.

30. One of the criteria used for defining the possible market in any country is per capita accumulation of steel stock. This might be used as a base for long range planning, but it is often a cause for errors in making financial and process forecasting. The rate of maximum absorption is the determining factor and is too often ignored, and the most difficult to estimate. Even in the developing countries, the rate is often over estimated. The patterns of consumption of the developed countries are not relevant models for the less developed countries, and cannot be transferred intact.

31. One of the evident ways of increasing the size of the market is through regional collaboration. Unfortunately, the enlarged markets mean greater transportation problems, as well as in the problems presented by the differences in exchange policies, monetary systems, and

great possibility of unequal benefits. It is the country that has the steel plant which will usually secure the most benefit from regional development. Fewer difficulties would be presented in regional collaboration for research, development, and standardization.

Influence on Society

32. To achieve success in the industrialisation of a developing country it is necessary to produce the social conditions to receive the industrial concept. Developing economy is an economy which requires a shift from a traditional rural, agricultural base to that of an urban, industrial base. This involves a change from a tradition oriented to a market or technology oriented culture. Economic development does cause a change in social institutions, psychological attitudes, perhaps even in idealogies and religions.

33. The developing nations need not only the motivation to achieve, but they must undertake broad society-wide programs if they are to successfully industrialize. McClelland states a series of psychological strategies which he believes are fundamental to social change and industrialization:

1. the gradual substitution of "other directedness" and "market morality" for existing values which compete with them such as "inner directedness" or "class or caste" morality
2. decrease of the father figure dominance and substitution of habits of independent choice and action
3. the introduction of idealogical reforms to unify other directedness, market morality, and decreased father dominance
4. the gradual introduction of educational programs with both short and long term benefits in the basic skill and knowledge requirements of an industrialized technological society

5. the reorganization of fantasy life to conform with a new cultural milieu

6. the use of existing need achievement resources more efficiently

The unpleasant facts are that they want their own version of old century nationalism, perhaps including military aggrandizement against their neighbors. They wish to retain their own cultures, beliefs, and attitudes. They want it both ways, as they also want the developed countries' institutions, industries, trained manpower, and capital. The fact that the behavioral pattern is so important as to swamp the economic facts of life is simply ignored because they are difficult to handle and potantially dangerous as political tools. Yet these factors are the keys to efficient industry.

34. Some theory is needed on how to change behavior quickly and to manipulate people. New income means learning to consume in new ways. It means an entirely new way of life. Is the individual going to respond or resist the change? It means educational decisions have to be made, decisions as to whether the individual will send his children to school, and as to whether he himself will try to learn more to become an effective worker.

35. The production of the rural economy is basically that of a "one man shop", where it is considered more of an art than a science. The transition from craft industries, where the man has great pride in his ability, to that of machine production which eliminates his pride in craftsmanship to that of laborer is often difficult. It must be demonstrated that the new habit is more rewarding in order to supplant the old custom.

36. To most engineers, development is a linear progression toward economic ends measured in monetary units. The customer certainly should view development not only as being oriented toward efficiancy and profitability, but as something that will achieve political and social stability, including protection of weak and inefficient industries.

37. The successful engineer therefore must have good insight into these implications and envision the changes brought on in social and cultural patterns. He must make every effort to avoid any disadvantages that could outweigh the expected benefits. The role of science and technology is that it must act as a catalyst for changing society so that an industrial system will be accepted and propagate.

38. Fortunately, the engineer has learned by experience in the developed countries how to overcome some of the disadvantages brought about by industrialization, those so aptly included in the term "ecology". He is aware of the environmental problems brought about by a headlong dash for development. The price that has had to be paid has included pollution problems, spread of disease, loss of farmlands and habitats of both people and wildlife. He is now able to take advantage of the errors of the past and is doing so.

39. The writer is personally aware of an excellent example of a project designed with great concern for the impact it would have on the people in the locale. The project, while not a steel industry, was evolved on aiding the local residents, mostly agrarian, economically and socially with the least disturbance to their existing customs and beliefs.

40. In the first instance the long range plan was limited in size, so that the immediate area would always be able to grow the needed amount of raw material. The method of growing and harvesting the raw material was changed very little from the existing methods. Pollution was controlled so that no damage would evolve. Water supply was carefully studied so that it would not have any disadvantageous effect on the villagers, and in addition an efficient irrigation system was also included. A village complete with homes, all community supporting facilities, including utility systems and schools with teachers were provided and most important, all of this was done without a patronizing attitude.

Training

41. Unskilled labor is abundant in the developing countries; semi-skilled, skilled, technical, and management specialists are usually scarce. Skills have to be created from an abundant unskilled labor

supply and training is therefore an important step in industrialization. Most of these countries have available a number of unemployed or not utilized college graduates. There is usually a certification psychosis present in these countries with the belief that no one can do anything without going to a formal school, and that if one is certified at the proper level, he is able to do the job automatically. These people have no place to apply their knowledge, and have received no 'practise' training. This is the principle source of the supply for the higher echelon of management, and is the group which will receive most of the advanced form of training either in their own country or in a foreign one. It is in the lower levels that less thought has been given to training. Some of the supplier countries have done an excellent job in grading the various levels and providing the necessary training, but they are all too few. One of the ways of reaching this lower group might be to work out a program with the various schools within the developing countries so that they will combine both the formal and on-the-job training. You may call it manual training in the more rudimentary form, if you wish, or cooperative training at the college level, but this would certainly fill a need. Resistance would have to be overcome at the college level, as those who would normally go to these schools would resent the new students who would not be able to go under the old system and who would feel it might lessen the status symbol of their certificate. The colleges themselves may resent it for the same reasons. It must be remembered, however, that individuals teach themselves through interaction with each other, both inside and outside of the classroom. They learn by doing.

42. The knowledge of the developed countries has accrued over the centuries and now the developing countries have discovered they have decades to cover in a few years. Besides training trainees it is often necessary to teach teachers. There is no way to avoid the requirements of training.

43. The general belief seems to be that some degree of mechanization or even automation will permit the use of lower skilled operators. In reality, while the skills of part of the labor force are reduced, the skill requirements of other portions of the labor force, such as

maintenance people are greatly increased.

44. One thing is certain. With technology constantly advancing new materials, processes, and products, and increasing efficiency and quality; with the requirements and capabilities of the developing nations constantly expan ing, training must be c a continuing bas and cannot be cut off with the completion of a specific project.

Electronic Data Processing

45. The developed countries, during the past two decades, have made great strides in the use of electronic data processing in various phases of industry. A great amount of time is saved in engineering calculations and in many cases producing through plotters the actual construction drawings. As for management, the various information systems available have been an invaluable aid. Process control by means of the computer is constantly advancing, and in some cases such as in high speed, high tonnage rolling, it is beginning to be of value. Process control, while very glamorous, usually follows the automation of plant management, accounting and inventory control. While certainly this knowledge should be transferred to the developing countries, its application should only be considered in the more advanced developing countries. In most cases the developing countries will find it is too advanced, too intricate to be used. The need is not there, as the use of the computer by the developed countries has progressed in order to save labor, improve quality, and increase efficiency. Too many million tons of steel of perfectly usable quality have been produced without the aid of the computer and it would only complicate the initial start of a beginning industry in a less developed country. It can be an aid, however, when used by the developed country in setting up the industry for the undeveloped country.

46. Dr. Chen and Dr. Hoelscher of the University of Pittsburgh, recognizing the seriousness of questions raised about the wisdom and the effect of replicating growth paths of the developed nations in the now developing nations, have presented a systems approach based on three levels of modeling. The first level is that of a single industry and is based on its own internal flow and process. It considers the physical

and monetary inflows and outflows, the costs for removing pollutants, costs of raw material inflows as well as profit outflows and results from a suitable analysis can yield, among other things, the optimum level of industrial operation.

47. The second level concerns the interdependency of one industry upon other industries.

48. The third level includes the social, political, and other non-technical, non-economic variables which are essential parts of industrialization. The suitable analysis of this type of model would yield

1. the necessary external stimulus to help achieve a selfsustaining growth
2. the effect of stretching out or applying a concentrated dose of external stimulus
3. the effect of changing the social system in various degrees

As they point out, it has not been done before and grave questions arise as to the ability to provide the data needed for the third step. But they believe it can be done and that it must be done.

The Government Role

49. The role of the participation of government has intentionally not been mentioned till now. Obviously, development cannot flourish without good government. This means a strong government which is able to maintain law and order, protect person and property, eliminate corruption, provide the basic public services and maintain efficiency in the apparatus of government at policy-making and execution levels. The government must be willing to cooperate and to invest with other nations. It must recognize that a profit element is necessary to encourage development of industry. This is true even if the project is government owned, but in this case profit may be considered as other than a strictly monetary gain. Government must be prepared to support industry through its allocation of resources, education, trade, tax and transportation policies; labor, health and safety regulations; in short, government must provide

the receptive climate.

A Case in Point

50. A very interesting steel plant has just been erected which may be considered a model plan for starting a steel industry in a developing nation. It is the Siam Iron and Steel Company, Ltd's. plant located at Ta Luang, Soraburi. Without knowing anything of the financial feasibility, one has to believe after studying the technical-social aspects that it has been well thought out. Some of these features are

1. Scale - Small, planned for increasing as labor is trained and capital becomes available.

2. Process - Integrated. Blend of modern, including electric furnaces, B.O.F.s and continuous casting plus old, including charcoal blast furnaces. In all cases the units have been tested. Thought given for increasing through four stages. Uses local raw materials. Equipment planned so as not to cause too much interference to production if a unit is down for maintenance.

3. Market - Available within the country, no dependency on any foreign market. Quality not demanding.

4. Social Impact - Careful thought given so as not to disturb any existing industries. Make use of existing charcoal industries. Will provide work for others in reforestation with little training required.

51. SISCO, the government, and the engineers should be commended for the thought given in the selection of this plant. Courage is required and pride has been set aside in arriving at a decision to build an integrated plant with blast furnaces of this size. In fact, this concept is probably beyond the scope of most of the heavily industrialized world.

52. The developed countries have a tremendous fund of knowledge they can bring to the aid of the developing countries and they are willing to transfer that knowledge. Organizations such as UNIDO have been established to act as a means of communication for the transference of this knowledge between the developed and developing countries. The governments of the developing countries must provide the receptive climate. One thing is certain, the citizens of these countries desire to close the income per capita gap and will not be patient much longer.

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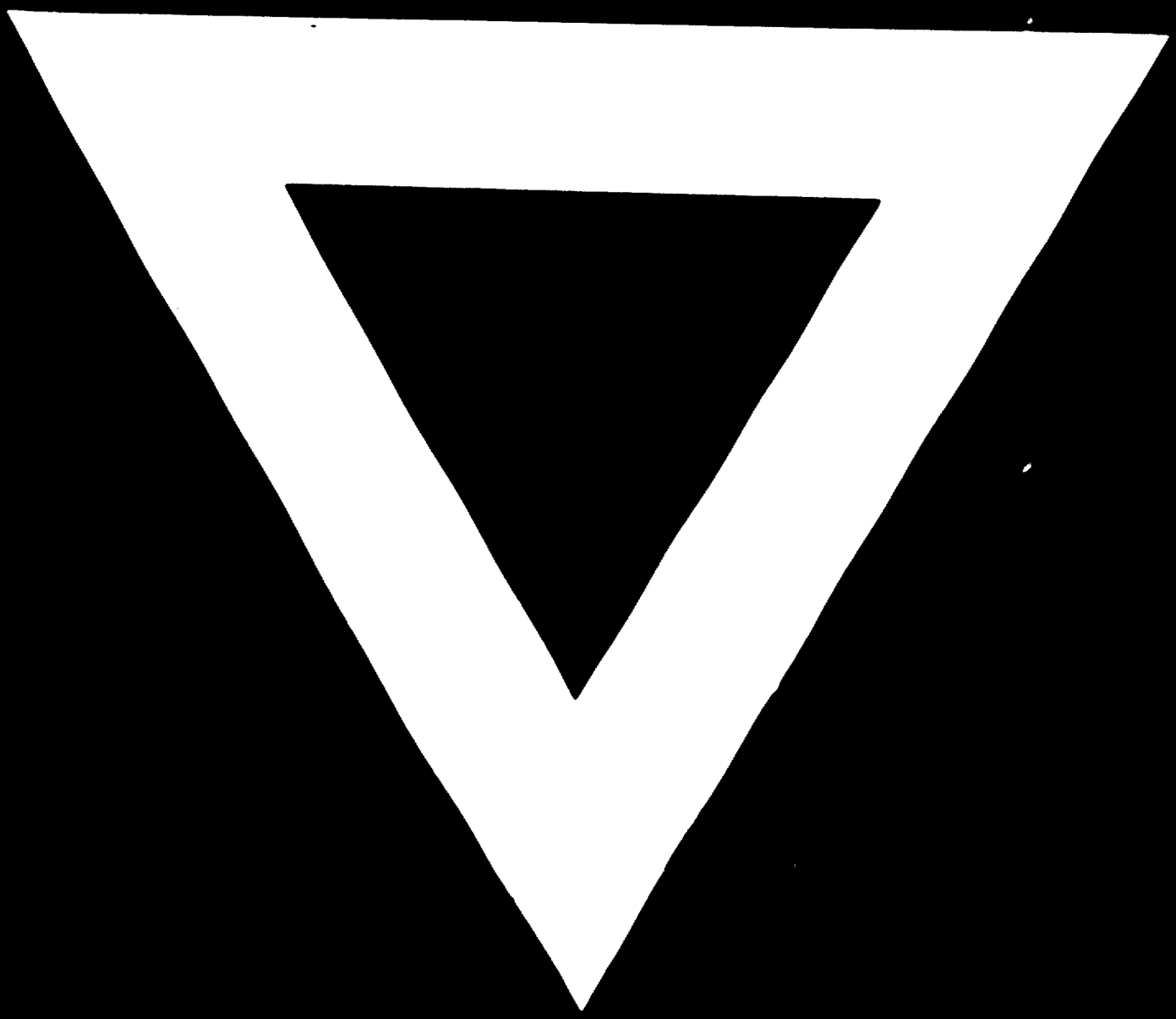

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