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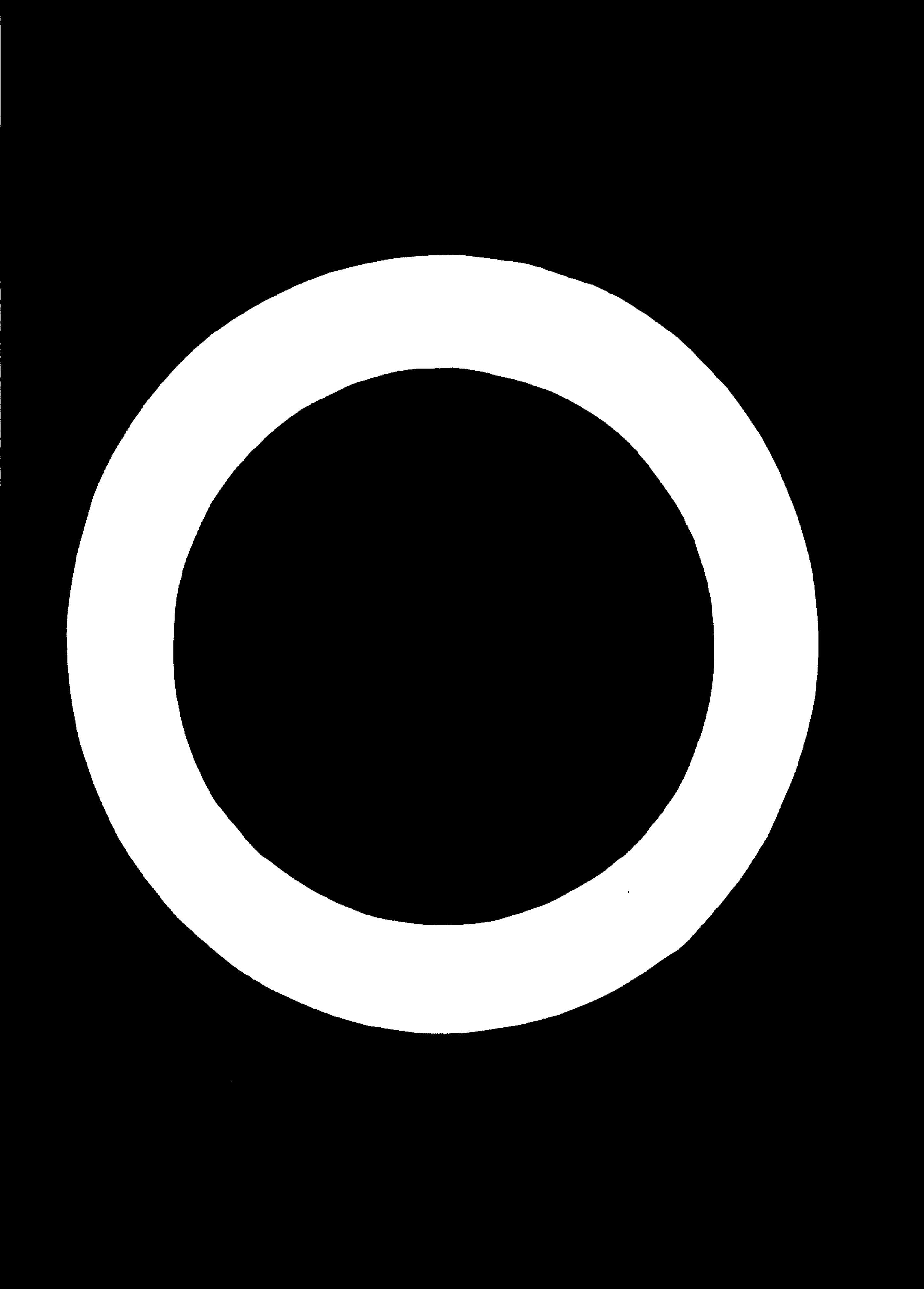
D04613

Industrial Research and Development News

VOL. VI No. 3

IRDN

UNITED NATIONS



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UNITED NATIONS PUBLICATION
Price: $U.S. 1.25 - Annual subscription $U.S. 4.50
(or equivalent in other currencies)

UNIDO

United Nations
Industrial
Development
Organization,
Vienna

Industrial Research and Development News

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VOL. VI No. 3

**United Nations,
New York, 1972**

TECHNOLOGY TRANSFER MODEL

by Samuel N. Bar-Zakay

Technology transfer has been described as the generation and/or use of scientific or technological information in one context and its re-evaluation and/or implementation in another [1].

Technological forecasting has been defined as "the probabilistic assessment of the feasibility of future technology transfer" [2]. To date, however, there are no hard and fast rules for making such an assessment.

The question of assessing the feasibility of future technology transfer is far more than an academic one. It is widely believed that there is an inherent threat to world peace in the fact that two thirds of the countries of the world, accounting for 70 per cent of its population, currently have a GNP per capita of less than $U S 500 [3]. Indeed, as Pope Paul VI has noted: "Development is the new name for peace." [3] Since the rate of economic development is related[1] to the rate of technological development [4], improving our understanding of the technology transfer process is of prime importance.

The model for technology transfer described in this article is presented with three objectives in mind:

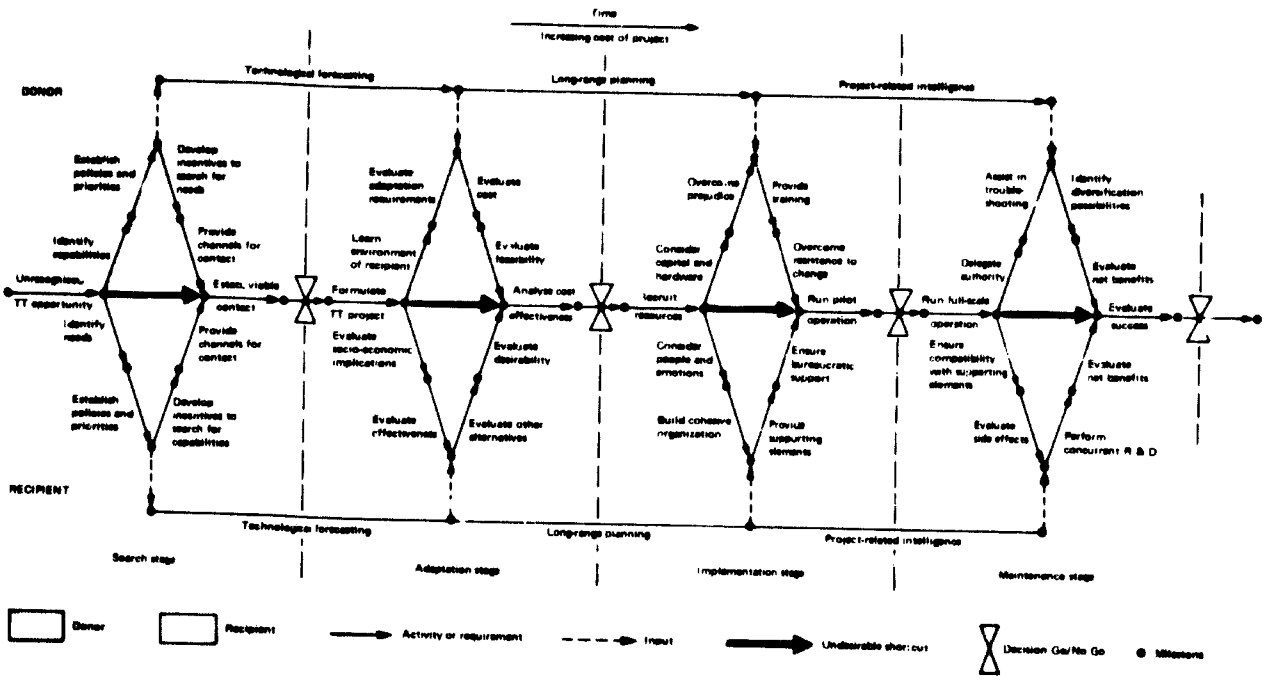
- To suggest a list of activities to be undertaken in a specified sequence by individuals and organizations intending to engage in a technology transfer project;
- To aid in the assessment of technology transfer projects by listing the elements involved in the process;
- To point out areas in which knowledge is limited and which require further research.

It is hoped that the model will stimulate thinking on several aspects that will only be implied here. For example, although there are differences in magnitude and relative importance, the forces involved in the process of technology transfer are the same, irrespective of whether it takes place within a country or between countries. Therefore, it should be possible to apply experience gained in, say, transfer within one country to transfer between countries.

The study of innovation diffusion as a spatial process is closely related to the study of technology transfer. Geographers have attempted to develop mathematical models of the diffusion of innovation, but as Brown [5] has pointed out: "One shortcoming of the mathematical models presented . . . is that the conceptual framework must be moulded into their form, rather than vice versa."

All in all, an interdisciplinary approach to the study of technology transfer must be made before any major advances in our knowledge of the process are possible.

[1] Even if the relation is difficult to measure ("residual" analysis problems), it is important to remember that the assumption that a relation exists is well entrenched, especially in the developing countries.



TECHNOLOGY TRANSFER MODEL

The model

Activities, milestones, and decision points are illustrated in the semi-PERT diagram above.[2] The basic rule of PERT is that no activity may start before all activities and inputs leading into it have been completed. The model is divided into two major parts by a horizontal centre line: the elements above the line (shaded areas) represent activities and requirements that are of major importance to the donor of the technology and should be carried out or fulfilled by him; elements below the line represent activities and requirements that are of major importance to the recipient and should be carried out or fulfilled by him; elements listed along the line represent activities that should be carried out by both donor and recipient. Though both parties are concerned with all of the activities mentioned in the model, their relative importance to one or the other party are thus indicated.

The model is divided into four stages in the direction of the flow of action: search, adaptation, implementation, and maintenance. There are four major points at which it may be decided whether to terminate the project or carry on. The farther one advances to the right, the higher the cost of the project. Thus, it is desirable to be able to make an "educated decision" [1] as early as possible in the process whether to go forward. The considerations that should be taken into account at these decision points will be summarized later. Feedback lines have not been drawn to keep the model simple; however, at each milestone, conclusions should be drawn and fed back to the appropriate place.

At the top and bottom of the model three types of activities—technological forecasting, long-range planning and project-related intelligence—are listed correspondingly for the donor and the recipient. These activities may be carried out independently of the technology transfer project; however, their output is of such great importance to the project that they would be of greater value if they were carried out in the sequence suggested in the model.

The probability of success of any technology transfer would increase if the donor and the recipient were to perform the activities or satisfy the requirements outlined above and below the horizontal centre line. Many individuals and organizations engaged in technology transfer are taking shortcuts (indicated by wide arrows) which often lead to unsuccessful transfers.

A corporation or a country may be a recipient of technology in one instance and a donor in another. For example, Spain is importing technology from the United States while providing various types of aid to the Latin American countries. The donor and the recipient may even be two parts of the same organization. Further-

[2]PERT: Program Evaluation and Review Technique, described and discussed in most books on operations research. For example, see reference 6.

more, the activities and requirements outlined in the search stage may represent considerations in the mind of an individual. In all cases, however, the activities listed in the model are taking place, consciously or not, though, obviously, the more aware the donor and recipient are of these activities the better the chances for the success of the project.

Many examples of the use of the model are given in the paragraphs that follow, but it is by no means restricted to these examples. In order to illustrate its general applicability, the examples are drawn from diversified fields and from cases of transfer within countries and between countries.[3] Thus, the recipient may be a country in one example and a businessman in another. Similarly, a donor may be a corporation, an individual, or a country.

Each activity and requirement mentioned in the model is discussed, starting with the search stage and ending with the maintenance stage. The reader might, therefore, find it helpful to refer to the diagram every once in a while during the course of the discussion. Too literal interpretation should be avoided: the performance or neglect of certain activities is a matter of degree. In this sense also, the extreme case in which both donor and recipient have carried out their activities in a superficial way is designated an undesirable shortcut. It will become clear from the discussion, however, that a technology transfer project may also be crippled by negligence on the part of either or both of the participants in any of the elements mentioned in the model.

The search stage

A prerequisite of technology transfer is the existence of an (unrecognized) opportunity for it to take place. This is emphasized at the outset in order to indicate the necessity of some sort of "innovation/intelligence/analysis" capability on the part of the participants to discover this opportunity. The word "innovation" is used quite often in discussions of technology transfer [7], yet the existing literature gives the impression that only a single innovative step is involved. It will become clear from the following discussion that many innovations, in a broad spectrum of disciplines, are required in order to make technology transfer successful.

Very little is known about the nature of inventions [8] and innovations [9], and it is the intention here to structure these needed innovations into operational terms.

Recognition of capabilities may spur innovation. This may be induced by awareness of needs, or of a hitherto unrecognized opportunity for technology transfer. It is not beyond reason to assume that if a corporation were actively to review its capabilities, novel ones would be found. For example, a major chemical corporation in the United States has recently set up a new division for industrial training. The company had realized that in the course of establishing manufacturing plants in developing areas it had gained experience in, and developed techniques for, training unskilled workers. However, policies and priorities must be established in a corporation before specific capabilities can be exploited, and in this case the training capabilities were not available for transfer until the corporation had set priorities for the types of new businesses it wished to enter.

Though awareness of the recipient's needs is essential, it is not sufficient; it must be followed by the setting of policies and priorities. An example of a case where this sequence was not followed is provided by a state run chemical corporation. The country in question, aware of the need to increase exports in order to improve its balance of payments deficit, devised a plan for the integration of its chemical industry, to be coupled with extensive technology transfer from foreign countries [10]. Thus, a corporation was formed to integrate operations of all the government-owned chemical companies. It was estimated that the annual sales of the newly formed corporation would increase from $100 million to $300 million in the next seven years. A great deal of money and effort went into detailed planning and making contacts with potential donors before it was realized that certain fundamental policies and priorities had not been established. The management of the individual chemical companies did not want to relinquish control to the new corporation. The corporation, for its part, was unable to carry out any of its plans as it lacked control over the individual companies. Consequently, a project that was thought to be technically feasible and desirable for the country could not be executed. A great deal could have been saved if the Government had decided at a preliminary stage that it was not going to force integration on the individual companies.

The recipient formulates policies designed to attract donors. For example, the developing countries provide tax advantages for foreign investors. However, studies [11] have shown that this type of incentive is not the primary factor that attracts donors of technology. Much research is still needed in order to establish the optimum combination of incentives for this purpose.

Once the donor has met the first two requirements, incentives to use its capabilities may evolve or may have to be developed. For example, when another major American chemical company made a policy decision to become an international corporation, an incentive was created to use its food-processing capabilities to solve needs in other parts of the world. This resulted in it producing a high-protein drink in Guyana which was of great benefit to that country [12].

The recipient is also in need of incentives, but they are of a different type. He must search for capabilities if

[3] However, the emphasis in this article is on technology transfer to developing countries.

a technology transfer is to take place. A case in point is that of an adhesive manufacturer in the Republic of Korea who found that his vinyl-coated fabric was not suitable for export because of quality-control problems. Instead of acquiring the proper technology to alleviate the problem, the manufacturer chose to exploit the internal market even though it meant competing with a similar product imported from Japan. The manufacturer might have made a different choice had there been better incentives for exporters.

Both donor and recipient require channels for contact in order to match their capabilities and needs. Gilmore *et al.* [13], who have studied the channels of technology acquisition in commercial firms and in the National Aeronautics and Space Administration (NASA), have identified the importance of viable contact between vendor and recipient. By viable contact is meant an opportunity for exchanging information and ideas, the availability of a common language, and especially the ability to translate technological capabilities into human needs. It is obvious that in these three respects interdisciplinary groups representing recipient and donor would be able to establish viable contact more efficiently than individuals with restricted knowledge and interests.

At the end of the search stage comes the first opportunity for a major decision on whether to go forward together. Two important criteria should be used:

Compatibility of policies and priorities;

Personal compatibility.

If the donor has decided not to participate in joint ventures unless he has a controlling position, while the recipient has decided not to allow more than 50 per cent participation in any such ventures, it is obvious that the parties have no reason to continue their negotiations. If the donor looks down upon the recipient because of his primitive knowledge of technology or for any other reason, the parties should not continue their negotiations.

Unfortunately this logical sequence of events is not usually followed and an undesirable shortcut is taken in many cases. The production of diesel engines in a certain developing country may be taken as an example [14]. Several major policy differences were identified when the engine was already in production. One of them concerned expectations of return on investment, another concerned corporate policy on production control. It would have been more economical all round to have settled these questions in the search stage rather than in the maintenance stage.[4]

The adaptation stage

The first step in this stage is the formulation of a technology transfer project or process. This initial formulation will only serve as a basis for study and in most cases, if not all, will undergo considerable change before the next stage.

The donor has the responsibility of learning about the environment of the recipient. Failure to satisfy this requirement has led to many unsuccessful foreign aid programmes. For example, in the United States a solar cooker was developed for India. The purpose of the project was to conserve dung, traditionally burned as fuel in rural areas, for use as fertilizer. Prototype cookers were tested in the United States, shown to be useful, and shipped to India for field trial. Only then was it realized that the villagers work in the fields during the day and prepare their hot meals at night [16]!

Although both recipient and donor must evaluate the adaptation requirements, the donor is better qualified to perform the technical analysis, provided, of course, he receives the correct socio-economic information from the recipient. What happens in the absence of proper adaptation? An example is provided by the case of the new strains of rice developed by an international rice research institute and applied in several countries [17]. In one, the Republic of Viet Nam, where land is scarce and the cost of labour marginal the people work hard to minimize the cost of production by increasing the rice productivity per hectare of land. With the use of the new strains they hace succeeded in producing four tons of rice per hectare. But an attempt that is currently being made to transfer this technology to West Africa without adaptation is obviously a mistake. In West Africa land is plentiful but labour is scarce. The emphasis in this case should be on minimizing the cost of production by increasing the productivity of labour.

Technological forecasting on the part of the donor will provide the information necessary to evaluate the cost of a transfer project. The donor may also find out from this forecasting that, in addition to the policies and priorities established in the previous stage, he should supplement his technical know-how, at low cost, by means of an "acquisition". An example of what is meant by an acquisition in this case is provided by a leading construction company in the United States which recently "acquired" a ten-man company that had developed a new approach to producing compressors. The acquiring company thereby saved itself money in research and development and strengthened its position in the industry [18].

It is mostly the responsibility of the recipient to evaluate the socio-economic implications of the technology transfer project. The question of automation versus manual labour might be considered as an example. The project may provide automated equipment for, say, picking cotton. Yet manual labour may be a means for achieving income distribution, in which case automation

[4]It can be argued that the cost of certain decisions to the recipient may be too high at the search stage. For example, he may choose to defer some decisions in order to ensure the start of a project. In the opinion of the author this is a dangerous tactic. For a discussion of nondecision see reference 15.

would have undesirable side effects. In this stage efforts should be made to foresee possible socio-economic side effects, but these will be discussed again in the maintenance stage.

The recipient has a further responsibility to evaluate the effectiveness of the project. This evaluation is far from simple. The president of one developing country objected to a new method of destroying infant-killing swamp mosquitoes on the grounds that he would be unable to cope with the resulting population explosion. Effectiveness should be defined here as producing the desired effect in the broad sense of the word. Knowing the local conditions, a recipient may come to the conclusion, for example, that modern tractors will be ineffective in his environment because of the lack of maintenance facilities.

After evaluating the socio-economic implications and the effectiveness of the proposed technology transfer project, the recipient can integrate the findings of his own technological forecasting. This will enable him to evaluate alternatives to the proposed project. The lack of technological forecasting in the developing countries leads in many cases to the purchase of inappropriate technology. A developing country may establish a chemical plant producing 5,000 tons/year, while elsewhere plants producing 100,000 tons/year of the same chemical are being built. The recipient should be able to assess whether the product from the small plant will be able to compete on the world market.

It is the responsibility of the donor, mainly, to evaluate the feasibility of the project (with respect to patents, marketing possibilities, return on investments etc., in an industrial project), but it is the responsibility of the recipient to evaluate its desirability.

Only after the activities mentioned above have been carried out can the parties to the project perform a cost-effectiveness analysis. At the end of the adaptation stage they face a second major decision point. The criteria at this point are:

- Degree of consensus on feasibility and desirability;
- Cost effectiveness commensurate with policies and priorities established in the search stage.

The recipient may decide to drop the project at this point because it may, for example, raise expectations in the country to an undesirable level. The donor may be of the opinion that such a danger does not exist. If the parties continue in spite of the disagreements, the recipient will tend to blame the donor for any political difficulties that may arise. The donor may decide to drop the project at this point because, say, the estimated return on investment after adaptation is not commensurate with his initial policies. If the donor continues in spite of this, he will be operating under limited options and may have to disengage upon the first financial crisis.

Had the shortcut been taken, the formulation of the project would have been followed by a less complete cost-effectiveness analysis, the requirements discussed above would not have been taken into account, and the entire project would probably have resulted in the waste of valuable resources.

The implementation stage

The implementation stage starts with the organizing of the necessary resources: the donor assumes responsibility for capital resources, the recipient that for human resources. The donor presents the feasibility-desirability study (prepared in the adaptation stage) to an aid-supplying organization such as the International Bank for Reconstruction and Development (IBRD) and requests a loan for the project. If hardware is involved in the transfer, the recipient should guard against the donor's supplying him with obsolete equipment. Estimating hardware requirements is further complicated by the transfer to the new environment. For example, Strassmann [19] has indicated that a nitrogen fertilizer plant that would cost $1 million in the United States might cost $1,350,000 delivered at a Central American site. Also, because of differences in wages, salaries, productivity and spare parts costs, maintenance and repair expenditures are different in the two locations. For example, a 15-year life in the United States costs 5 per cent more a year than a 10-year life, whereas in Central America maintenance and repair expenditure for a 15-year life cost 6 per cent less than for a 10-year life [19]. Thus, the less sophisticated equipment may be a better choice. The participants may not have been able to evaluate such problems in the adaptation stage owing to their high expectations of the resources that would be available. However, if in this stage they receive only half of the expected resources, the choice of equipment has to be reconsidered.

Closely related to the above is the need for the donor to assign unprejudiced people to the project who can provide training to the recipient. Spencer and Woroniak [20] have noted that "By treating human capital as analogous to physical capital, we encourage the implicit assumption that training and ultimately the educational system as well, should be looked on as part of an economic production function, determined by the imported technology and without much respect (even occasional lip-service) to the contemporary cultural values." This attitude appears to be a major factor in the failure of transfer projects, though it is seldom mentioned in the literature. The president of a large American engineering corporation that has been working for 15 years in a developing country, has explained his difficulties in this connexion: "I interview the manager and his wife several times before they go overseas, yet it is difficult to predict how he will behave in the new environment. The success or failure of the project may depend upon the attitude of that manager towards the local citizens." For this, and related reasons, supervisors from environments similar to those of the trainees should be preferred and if trainees must be sent overseas, a country similar to their own should be chosen [21].

The application of behavioural science to studies of aid programmes and training programmes in developing countries is quite recent. However, it can be an important tool in the hands of the donor when attempting to overcome resistance to change (after the project has been found to be socially and economically desirable in the adaptation stage). For example, a case study [22] has shown that in a project in which all production employees had participated by designing the job to which they would be assigned suggesting, or actually making changes in the job description themselves they learned faster, had fewer grievances, less turnover, and higher efficiency than employees trained by the usual methods.

Since several years may elapse between the adaptation stage and the implementation stage, long-range planning is important, as indicated in the model. Before the implementation stage is reached, the donor has carried out his long-range planning and is equipped with the necessary knowledge. For example, in the case of the training capabilities of the corporation mentioned earlier, once a corporate policy was established to capitalize on these capabilities in the search stage, technological forecasting activities identified the relevant technologies. Subsequent long-range planning activities have prepared the corporation for the step of providing training in the implementation stage, as indicated in the model.

The major responsibility for recruiting human resources is assigned to the recipient because he is better equipped than the donor to evaluate the necessary incentives and criteria for selection. It has been argued, and probably correctly, that the blame for the "brain drain" from a country lies mostly with the country itself [23]. The recipient has a better chance to identify and affect local policies that may reverse this drain. He knows in which regions of his country the most suitable personnel are to be found, and what incentives they will need [24]. In co-ordination with the donor, the recipient will determine the ratio of foreign experts to local participants in their new project.

Once the personnel are available, a cohesive organization has to be put together. This task is far from simple, owing to what can be termed differences in "value ladders". For example, Lee [25] has compared managerial qualities as envisioned by Ethiopian and American managers. American managers rank "decision making" third, while Ethiopian managers rank it eighth. At the same time Ethiopians rank "sensitivity to others' feelings" second, while American managers rank it only sixth.[5] Thus, it is clear that much thought (or preferably, research) should be given in the implementation stage to the problem of human resources for the new organization.

It is in the implementation stage that the recipient, with or without the help of the donor, should provide the supporting elements (possible industries) in order to ensure the success of the technology transfer project. This activity is obviously dependent upon the general infrastructure of the country. An example of the breadth of the supporting elements has been given by Baranson [14], who noted that in the case of diesel engine manufacturing in the United States, close to 200 plants supply materials, roll castings, forgings, components, and parts to the diesel engine manufacturer. Thus, it is a mistake to view the manufacturing plant for engines out of the general context of the supporting elements. It can be assumed that the successful introduction of the bicycle into South-East Asia as a revolutionary new mode of transportation was facilitated by the simplicity of the required supporting elements, such as small workshops for maintenance. In a planned technology transfer project, technological forecasting by the recipient identifies the required supporting element, and through subsequent long-range planning he ensures that these elements will be available at the appropriate time in the implementation stage. (The reader is reminded again that for simplicity no feedback lines were drawn on the diagram.)

Yet, even good systems analysis is not enough for the success of the project. The political forces and the bureaucratic structure should be taken into consideration. In transfers within the developed countries, the phenomenon of not-invented-here (NIH) has been described thus: "Laboratory directors frequently scoffed at the suggestions and refused to consider the possibility that someone outside their laboratories could come up with a more advanced development" [18]. In the context of the developing countries, several authors have written on implementation problems. The following quote was written in that context, but is by no means restricted to it: "Personal insecurity in a position of authority is likely to create personal needs of such magnitude as to dominate over organizational needs." The resulting pathological or bureaucratic behaviour is manifested in such forms as "close supervision, failure to delegate, emphasis on regulations, quantitative norms, precedents, and the accumulation of paper to prove compliance, cold aloofness; insistence on office protocol; fear of innovation, or restriction of communication" [26, 27]. Here, at the implementation stage the technology transfer team has the moral justification to try to overcome bureaucracy, if necessary. It is important to note that this responsibility, as indicated on the model, is assigned to the recipient. This is because he is in a better position to do it and because it is politically more desirable to effect change through local people. This step in the process is quite difficult and calls for additional research.

Once the activities outlined above have been carried out, the parties are in a position to set up a pilot

[5] The ranking was the same only for first place, "Develop new methods", and thirteenth place, "Maintain status difference".

operation. At this point they are by no means committed to full-scale operation. Their major aim at the pilot stage is to test their hypothesis and decide whether to continue with the project. Two important criteria should serve as guidelines:

* Identification of problems that require such changes in the technology transfer project that a completely different pilot operation is called for;
* Identification of problems that cannot be solved at the maintenance stage without excessive risk to either recipient or to both.

The maintenance stage

At this stage, when the technology transfer project is in full-scale operation, the donor should delegate authority to the recipient. This is particularly true when the ratio of donor/recipient participation has been high in the implementation stage. Individuals involved in technology transfer to developing countries, however, have noted that in many cases a donor is reluctant to take this step. There are several reasons for this: first, he is afraid of losing his control of proprietary information; secondly, he wishes to stay in the picture in order to protect his initial investment, being of the opinion that he can react better than the recipient in critical situations; thirdly, he may wish to keep key positions in order to ensure that the recipient shall continue to require his services for other projects in the future.

However, even after the authority has changed hands, the recipient should ensure that the donor will provide services such as troubleshooting [28]. Apparently, though, this opinion is not shared by all donors, and there have been cases of technology transfer that failed because the donor chose to disengage completely after the implementation stage. Between the two extreme cases of the entrenchment of the donor and his complete disengagement, there are obviously many intermediate levels, and research is required that will suggest some guidelines for the best time to hand over command in various types of technology transfer projects.

In the maintenance stage the recipient has the responsibility of assuring compatibility of the project with the required supporting elements, as the donor probably has no jurisdiction over, or channels of communication with, them. If an integrated industrial project is involved, it may be found that the spare parts produced by subcontractors do not fit parts produced by the major plant or that there are quality control problems [14]. If a new method for population control is introduced, it may well be found that what was feasible in a pilot operation is no longer so in a full-scale operation involving the total population.

Intelligence gathering and evaluation which has been carried out in all stages (e.g. as part of technological forecasting) should be continued during the maintenance stage. Such questions as "How profitable is my competitor's plant?" are usually not included in technological forecasting and should be raised at regular intervals. Unfortunately, once a transfer project is completed, the recipient usually loses interest in other alternatives. The intelligence gathered, and its evaluation, will assist the parties in deciding whether to continue the project. The nature of the intelligence activities will differ with donor and recipient. By definition, the recipient is need-motivated. Thus, his needs will persist as long as the project is not successful. His intelligence will involve, among other things, a search for other ways of satisfying his needs. On the other hand, the donor, who is capability oriented, will gather intelligence in order to evaluate whether he can use his resources more profitably in a different context (corporation, country, etc.).

Leading United States and European chemical companies have specifically pointed out that developing countries promise only distant profits. As the director of one concern has pointed out: "This entire business of attracting chemical industries with tax incentives is simply a matter of government competition. Like everything else, ... whoever offers the best package wins the investment" [29]. Since the objectives of the donor and the recipient in gathering intelligence are entirely different, they will use different techniques, and much is still to be developed by recipients in this field [1].

In view of the problems that develop in the maintenance stage, research and development activities should be undertaken that will ensure the viability of the project. In the model, these research and development activities have been assigned to the recipient since he is assumed to be deficient in the particular capability and must therefore develop it in a continuous fashion. The donor usually carries out some of these activities as well, however. Based on this research and the intelligence he has gathered, the donor may, in time, produce ideas that are complementary to the original technology transfer project, for example, diversification possibilities. These may be induced in part by his association with the recipient right up to the maintenance stage. It is desirable and appropriate that the donor explore such possibilities with his current partner rather than take advantage of them in a different environment with a different recipient. Since the course of action in such cases will depend to a large extent on the original agreement formulated in the adaptation stage or the implementation stage, it is important the the recipient raise these points at such times.

In the maintenance stage also the parties must evaluate their original expectations vis-à-vis the current performance of the project. Since the model is formulated in general terms, no fixed period for such evaluation has been assigned. However, as a broad estimate, it should be carried out at least once a year.

Even when dealing with a system of education where performance evaluation takes longer, it is desirable to assess net benefits at short intervals. The term net benefits is used for both recipient and donor for a particular reason: it is quite possible that the parties to the technology transfer project have started with one goal in mind and have achieved not that goal but an entirely different one.

For example, the recipient may have built a nuclear reactor for desalinization of seawater. The project may have failed because of the high cost of the water. But the recipient may find out that he is capable of educating a generation of nuclear scientists and engineers in his country thanks to the availability of the nuclear reactor. In another example, the donor may have been interested in building a fertilizer plant in the country of the recipient. The project may have failed owing to changing conditions in the world and a decline in fertilizer prices on the world market in which case the recipient would have been better off purchasing fertilizer rather than producing it. However, the donor may find out that owing to his knowledge of the environment of the recipient and to his good relations with the latter, he can now start a diversification programme. In other words, the success or failure of a technology transfer project should be viewed in the broad context rather than in the narrow one originally envisioned.

At some point in the maintenance stage, the success or failure of the project will be evaluated in the broad sense. Two major criteria should be considered:

- Original expectations versus current performance
- Net benefits

As mentioned before, conclusions must be drawn continuously and fed back to the appropriate place in the model. But the conclusions drawn at the maintenance stage are of even greater importance because of their potential in assessing the relative importance of mistakes and their effect on the outcome of a project.

Unfortunately, here again it must be stated that many technology transfer projects take the shortcut from full-scale operation to evaluation of success without consideration of the steps mentioned above in the maintenance stage. Furthermore, in many cases no evaluation takes place and crippled projects are allowed to die slowly instead of being terminated immediately. It is worth emphasizing that technologically sophisticated countries can just as easily fall into this trap [16].

It takes as much courage and wisdom to kill a project as it takes to initiate one. The absence of unsuccessful cases of technology transfer in the literature is proof of this statement. It is understandable that private corporations would not like to publicize their failures, but it is to be hoped that independent researchers in various countries will report relevant failures in spite of possible political sensitivities. [illegible]

[illegible] management [illegible] starting [illegible]

[illegible]

[illegible]

[illegible] developing countries [illegible]

Conclusions

Two conclusions emerge from the discussion presented in this article:

- For successful technology transfer to take place, the participants must have considerable analytic capabilities in the developing countries [illegible] system analysis, technological forecasting, [illegible] planning and intelligence gathering [illegible]. The more such capabilities [illegible], the more will the developing countries be able to analyse their resources [illegible], the more will they attract more technology transfer and the more will they absorb it successfully.
- Technology assessment in the developing countries must be performed by the developing countries. It is a well known fact that people are becoming increasingly concerned that the

general quality of life will be damaged because the wider effects of technological change are either not thought about or disregarded [40]. Yet it is interesting to note that the major programme on technology and society organized by one of the foremost universities in the United States does not concern itself with developing countries [41]. It is therefore not surprising to read that "One sometimes falls into the trap of developing with foreign aid a scientific establishment which is not concerned with the problems of that country" [42]. Thus unless the developing countries create the capabilities for analysing the socio-economic implications of technological development no one can or will do it for them and they will have to bear the consequences.

Where does all this lead to? To promote more efficient technology transfer and to act as catalysts to better policymaking, analytic capabilities must be developed in the developing countries. The analysis of technology transfer may have to be institutionalized; if so the new institutes should be interdisciplinary and staffed by local people. This would provide a more efficient operation, avoid political difficulties and leave no grounds for statements such as "Sometimes I wish all the foreigners would go home" [43].

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BUILDINGS

by [illegible]

…S OF CLAY

Many developing countries are now exploiting local clay deposits as the basic raw material in the manufacture of bricks or blocks for the building industry. Not that there is anything new about the use of clay as a building material: its excellent aesthetic and technical properties (see table over) are widely known and have been put to work with good effect all over the world down through the centuries. What is new, however, is the approach. Prefabricated wall panels, partitions, floors and roof structures of clay are now playing a significant role in the building programmes of developed and developing countries alike.

This article will describe briefly some of the methods that utilize clay as the basic raw material for the manufacture of clay modules.

Production methods

There are three principal types of panel in use:

1. Horizontal
2. Vertical
3. Inclined

The first two lend themselves readily to automated mass-production techniques while the third requires a high labour input to make it competitive. The horizontal panel is the one most often used. It can be constructed on-site by unskilled labour.

Clay block panels

This type of panel is constructed from hollow clay blocks.[1] It is quite light in weight which makes it easy to handle and transport and simplifies erection on-site. The production process is also simple. The clay blocks are laid in a form on top of a layer of gypsum or mortar and reinforced by wire rods throughout the length of one side. Cement is poured into the joints and on top of the blocks to form an even surface. The gypsum-coated side is the interior of the panel and the cement-faced side forms the exterior which may be painted or treated with coloured mortar to give a more attractive finish.

[1] Hollow clay blocks are also used in the manufacture of prefabricated reinforced beams for various forms of floor and roof construction. A special application is [illegible]

The Lamelkogl panel

The Lamelkogl panel is used to illustrate a typical vertical construction. Development of this panel, which is reinforced both horizontally and vertically, began in 1963 using a 29 cm x 9 cm x 23 cm hollow clay block. In later development, 28.5 cm x 8.5 cm x 9.5 cm blocks were used for both the exterior and the interior sides of the wall, with mineral wool in between, to a total thickness of 30 cm. The panel is manufactured by non-skilled but specially trained labour using corner posts and marked lines. The k value for the panel is 0.65.

Advantages of clay block panels

- They are normally lighter than concrete panels which means reduced transportation and erection costs; and
- They are dimensionally stable. Dimensional changes caused by moisture and temperature fluctuation are rather small which means that joints between panels may be less complicated and thus less expensive.

Recommended reading

Papers presented at the International Conference on Masonry Structural Systems, held in Austin, Texas, 1967.

BRYRUP, Jørgen: "Development of structural clay facing wall panels in Denmark".

BALCHEV, Bacon and MITEV, Ilia: "Some investigations concerning design, technology and test of sand brick panels".

[illegible] V. I. D. and [illegible] G. V.: "14-storey building in Switzerland with brick wall elements prefabricated by Preton process".

Many special types of blocks for roof construction have been developed. The aims of lightweight and semi-prefabrication is clearly illustrated here

Recommended reading (continued)

WAKEFIELD, Donald A. "Prefabricated brick panels in Colorado"

BRYRUP, Jørgen. "Panneaux à parement en briques: un tour d'horizon international" ["Brick Facing Panels: an International Survey"] (Paper presented at the Conseil international du bâtiment pour la recherche, l'étude et la documentation (CIB) [International Council for Building Research, Studies and Documentation], 5th Congress, France 1971)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION. "Structural clay wall panels" (Paper presented by Jørgen Bryrup at the Interregional Seminar on the Development of Clay Building Materials Industries, Denmark, 1960)

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION. "Draft Report" Meeting on Prefabrication in Africa and the Middle East, Budapest and Bucharest, 17-29 April 1972 (UNIDO document ID/WG.122/43) (mimeo.).

Technical properties of bricks made from clay

Air penetration (dry brick about 11 cm thick)	$\frac{1}{900}$ – $\frac{1}{50}$ $m^3/h \times m^2 \times$ mmHg
Permeability	0.007 – 0.03 g/h × m × mmHg
Specific weight	1,200 – 2,000 kg/m^3
Dimensional stability	
Temperature	0.005 mm/m per °C
Moisture (wet to dry)	0.1 – 0.2 mm/m
Chemical resistance	Excellent
Fire resistance	Excellent
Resistance to weathering (corrosion)	Excellent
Heat insulation	0.30—0.50 kcal/h × m × °C
Heat capacity	0.23 kcal/kg × °C
Compressive strength	200—600 kp/cm^2
Tensile strength	20—60 kp/cm^2
Modulus of elasticity	100,000—250,000 kp/cm^2

NITINOL – the Alloy with a Memory

by Herbert J. Wagner and Curtis M. Jackson

Battelle Memorial Institute Columbus Laboratories

The story of Nitinol, the alloy with a memory, begins at the United States Naval Ordnance Laboratory (NOL) in the early 1960s, when researchers W. J. Buehler and R. C. Wiley were looking for stronger, lighter, tougher materials to meet the needs of second generation missiles and spacecraft. Among the materials they considered was a group of compounds called intermetallics (which consist of two or more metals tied together in definite atomic proportions as in the case of true chemical compounds, though, unlike such compounds, they follow no simple rules of valency).

In addition to other intermetallic compounds, nickel titanide NiTi was examined. This is formed by melting nickel and titanium together in a one to one ratio (on an atom basis). On testing this material for hardness at room temperature, however, the researchers were disappointed. The compound was soft and ductile; the hardness tester left a large indentation. But when they heated the material to help improve its properties, the indentation disappeared. The compound had remembered its smooth, unindented shape! Thus, Nitinol was born (Nickel, Titanium, Naval Ordnance Laboratory).

More about Nitinol's character

This remarkable new material attracted quite a bit of attention and, while NOL continued its efforts, the National Aeronautics and Space Administration (NASA), the Atomic Energy Commission (AEC), and various industrial concerns also took a look at Nitinol. NOL investigators learned that the memory property was maintained over a range of 53 to 57 weight per cent nickel. For the alloys with the higher percentage of nickel, they found it useful to replace a little of the nickel with cobalt, to keep from forming Ni_3Ti, a detrimental compound. When they adjusted the composition carefully, the transition temperature, above which the original shape is recovered, could be varied from 300°F to +300°F on a controlled basis.

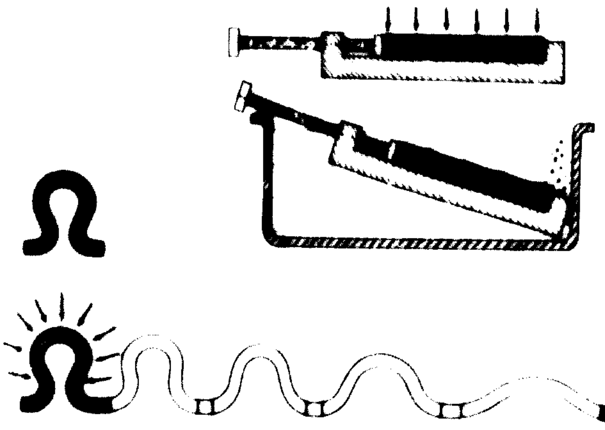

Figure 1.

Quite a difference was noted in Nitinol's characteristics in relation to its transition temperature. Below this temperature, Nitinol is soft, ductile, and plastic. When heated above it, the alloy gets harder and stronger, and its memory asserts itself. During cooling, the material softens again and becomes easy to form.

Other research people studied the amount of deformation that Nitinol could stand and still remember its original shape. They found that the material could return to its remembered shape after it had been deformed or strained as much as 8 per cent. Moreover, the shape recovery was good for cycle after cycle of straining, heating and cooling.

Perhaps the most important characteristic of Nitinol is how determined its memory is. Nitinol not only regains its shape — it works hard to do so.

Preparing Nitinol

Nitinol is not the easiest material to make and shape, but it is not the hardest either. Basically, preparation consists of melting the nickel and titanium together, with or without a touch of cobalt, depending on the composition and properties desired. Because hot titanium picks up oxygen easily, the melting is done under vacuum using either arc or induction heating. NOL has had success with vacuum-induction melting in a graphite crucible, starting with a little nickel or previously-prepared Nitinol to keep the titanium from reacting with the crucible. With these precautions under control, melting Nitinol is no more difficult than preparing most nickel-based alloys.

Nitinol can be forged, rolled hot or cold, or drawn by conventional means. The procedures follow those used for high-nickel alloys. Wire, rod, foil, sheet, and strip have been formed from Nitinol. So far, little attention has been given to extruding or casting shapes, but there is no apparent reason why these can't be done.

Last, but not least, comes the processing that builds in the memory of the desired shape. A piece of Nitinol is formed into the predetermined shape. Next the piece is clamped tightly (to hold the shape) and heated to about 900°F. Then it is cooled quickly by quenching in water. This completes the memory treatment. Provided that the 8 per cent deformation limit is not exceeded, this piece of Nitinol subsequently can be formed into any other shape, and it will snap back to its memory shape when it is heated above the transition temperature (see figure 1).

How Nitinol can be used

Nitinol is a brainstormer's delight. Its possibilities are endless, and once you get warmed up, the ideas for using it flow like water.

First, think in terms of Nitinol's capability to change shape. A small coiled ball made from Nitinol wire or strip, when sent aloft, could open up to the desired size and shape when heated by the sun. Other interesting possibilities include: self-spreading cotter pins for use in inaccessible locations, accessories to hold back hard-to-reach parts of the human body during surgery, and temperature-sensing devices. A huge range of possible uses pop out when Nitinol is considered for advertising novelties or toys.

Next, focus on the force that Nitinol exerts when it recovers its shape. A new class of applications emerges, e.g. in electrical devices the alloy might be ideal as the force element in current-overload devices or in current-actuated relays, where a minimum of mechanical linkage would be needed.

Nitinol might be especially potent in valves for fire-actuated sprinkler systems. Present valves usually go into action when a fusible link (of lead, for example) melts. However, if the envisioned valve were heated by a fire, the Nitinol component would return to its memory shape, say a tight coil, thus opening the valve and allowing the water to flow (see figure 2). After the fire is out, an opposing steel spring could shut the water off—as the Nitinol weakened during cooling—by restoring the Nitinol component to its extended-coil configuration and closing the valve. Since there is considerable difference between the force exerted by Nitinol when it is heated (above its transition temperature) and the force needed to extend the alloy when it is cold, the selection of an appropriate opposing spring would present no problems. Nitinol should really pay off in this kind of application. The common automatic sprinkler valve has no way to shut itself off; the water that pours out after the fire is put out may do more damage than the fire itself.

Self-fastening devices for inaccessible areas could exploit Nitinol's ability to change shape and exert force simultaneously. For example, the blind rivet made from this alloy could be set by applying a little heat to the head. It would be even better if the rivet were made from a Nitinol composition with a transition temperature that was below room temperature. The rivet could be kept refrigerated until needed; it could then be inserted and allowed to set itself as its temperature increased naturally. Such a rivet would have its maximum strength at service temperatures. Since the alloy's transition temperature can be as low as -300°F, this kind of rivet would be serviceable in almost any natural environment.

Other possibilities would be safety locks and heat-actuated pressure bottles. Nitinol also might be useful as the basis for an energy converter or a heat engine.

But, in spite of all this potential, today Nitinol is nearing commercial use in only one application, a heat-shrinkable tube coupling. From all reports, this coupling has given superior performance. Nevertheless, Nitinol for all practical purposes is still a laboratory novelty. What is holding it back?

The material-to-market gap

The element that has been missing in the Nitinol story is commitment—by producers and by users.

Nitinol has been brought to the point where its properties are reasonably well established, and con-

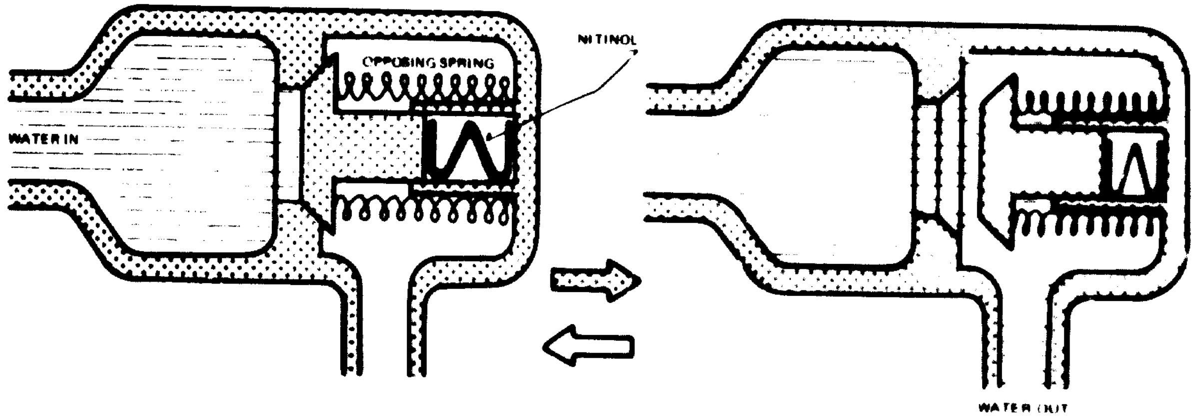

Figure 2.

Turn-on, turn-off sprinkler device. ***Sprinkler systems keep down the losses from fires; but what about the damage from the water that continues to sprinkle after the fires are out? Nitinol, because of its memory, offers a feasible answer. In the proposed sprinkler unit, the opposing steel spring holds the valve closed; the Nitinol component does nothing. As heat from the fire prods Nitinol's memory, however, the alloy asserts its force. Reacting to its memory of a tight coil, the Nitinol snaps to that shape and in doing so pulls the valve open against the opposing spring's force. When the fire is out, the alloy component cools and relaxes, and the spring closes the valve, shutting off the water.***

sequently matching the material to most of the uses mentioned above is feasible. However, thus far the alloy has been handled on a pilot scale; the additional information and know-how needed for scaling-up to produce and to apply it extensively are yet to be obtained. Nitinol today is at the stage where one step will make a big difference. This alloy can be a party clown or a serious performer, depending on whether commitments are made.

Commitment by either new producers or new users does not represent a trivial decision. Enough is known now about Nitinol to make it just about ready to go into toys and novelties. For sophisticated use, further developmental work is needed. For example, if a goal were set to produce parts by deep-drawing sheet, it would be important to obtain reliable data on how directional the properties of Nitinol sheet might be. In an application such as the blind rivet, where a high load must be sustained for a long time, it would be vital to know Nitinol's creep characteristics. For an item like a heat-actuated electrical contact, both fatigue and electrical properties would have to be established. For any usage, the effect of ageing on the pertinent properties has to be characterized; Nitinol's stability at ambient and service temperatures has to be determined. Moreover, since Nitinol's properties vary with its composition, complete profiles of the behaviour of the alloy as it is influenced by composition must be obtained for repeatability of the shape-change cycle, impact strength, tensile strength, elasticity, ductility, and other characteristics.

Processors, too, would have to know more about the alloy, for example, in regard to the times and temperatures used in the memory heat treatment and the effect of the stress that is imposed on the alloy during that treatment. Further, since even small changes in composition have considerable effect on the properties, tight quality control must be maintained on the material during production; this facet also needs investigation.

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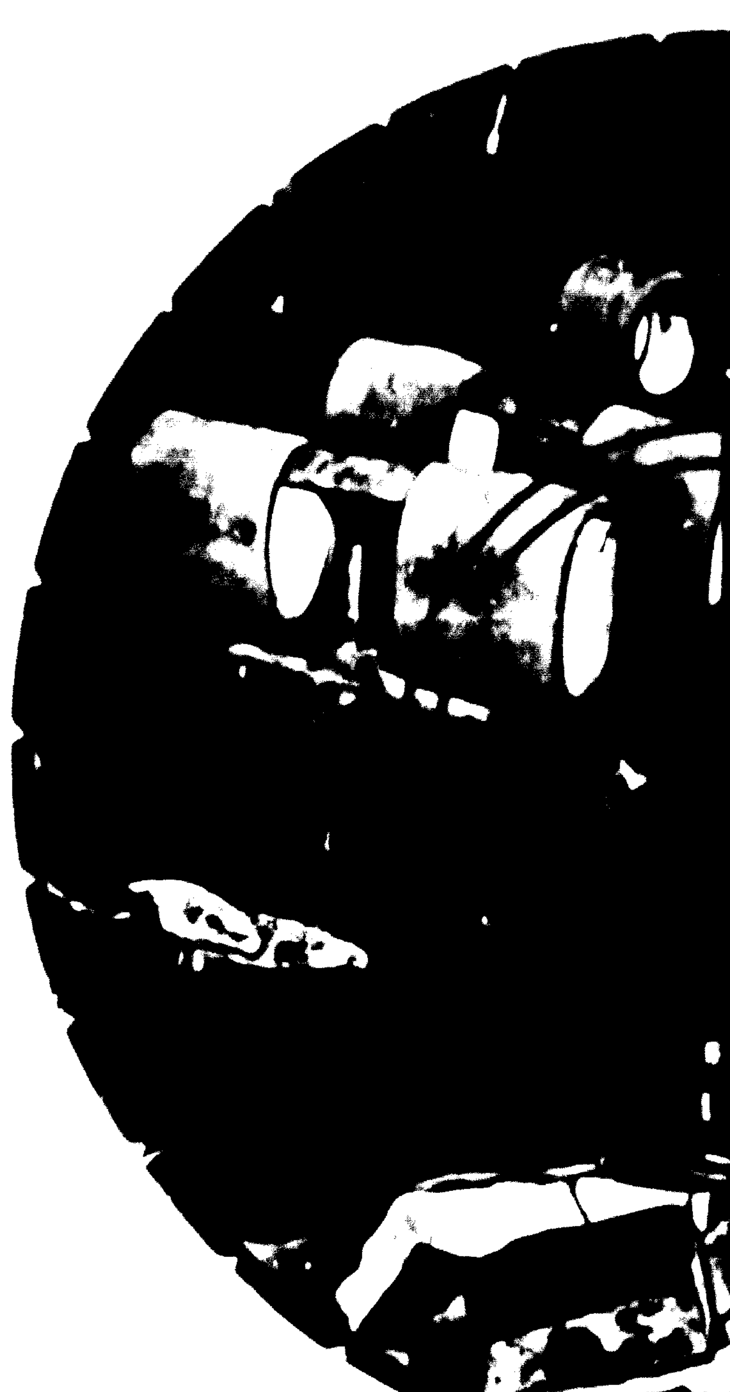
EGYPT'S RUBB



The world rubber industry, which is more than a century old, has been growing steadily during this period and is capable of continuing its growth. The rate of growth is governed by several technical, commercial and marketing considerations but the deciding factor is the ever increasing public demand for better quality, more durable, safer and less expensive rubber products.

To meet this demand the rubber industry, as well as related chemical petroleum industries, has been spending, and will continue to spend, considerable money and effort on research and development to introduce new materials, improved technologies, increased productivity and expanded marketing services.

Accelerated expansion in the rubber industry started after the Second World War, and consumption and production have been increasing ever since at an annual average rate of 6 to 7 per cent. In 1970 the world rubber demand was about 8.7 million tons; by 1980 it is expected to exceed 17 million tons.[1]

Natural or synthetic rubber?

Natural rubber was used for making all rubber articles before synthetic rubber became known and was available on an industrial scale. Today most of those products can be manufactured satisfactorily with synthetic rubber as a partial or total replacement for natural rubber. With the exception of truck tyres there are no applications for which natural rubber must necessarily be used for technical reasons. In truck tyres the replacement of natural rubber is restricted to the stereo-specific rubbers (polybutadiene and polyisoprene) and only up to a certain percentage of the total rubber hydrocarbon used in carcass and tread compounds.

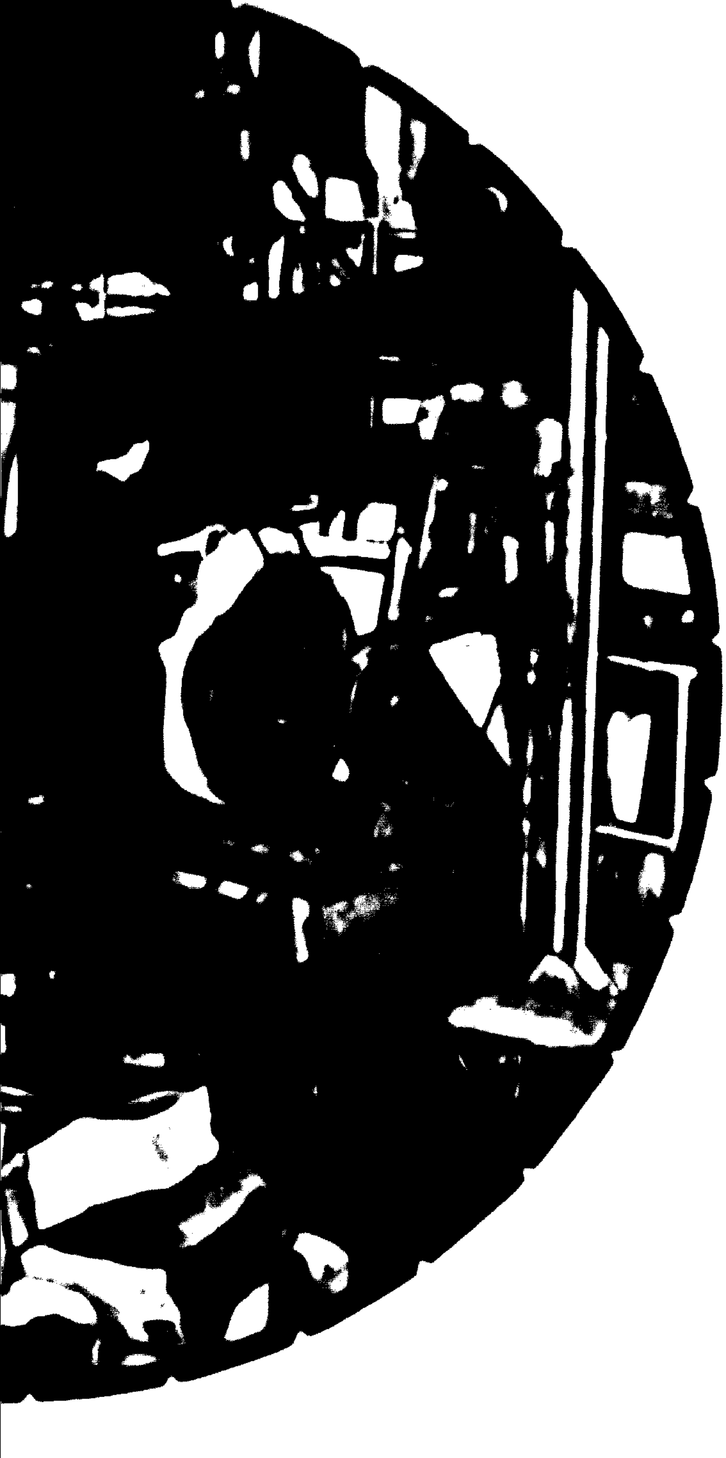
Since its emergence as an important raw material during the Second World War, demand for synthetic rubber has kept growing. In the course of the years from 1950 to 1970 production of this material rose by an annual average of 10 per cent as compared with barely 3 per cent for natural rubber, and in 1962 it outstripped the latter in importance. At present, synthetic rubber represents about 63 per cent of world rubber consumption and projections indicate that by 1980-1985 it will account for up to 72-75 per cent.

The reasons for this basic structural change were, of course, the special qualities of synthetic rubbers and their wider fields of application. Other important factors were the restricted character of natural rubber production and the fairly large price fluctuations resulting from variations in supply and demand. Natural rubber production could not be turned on or off to meet these market variations, which meant that within the total new rubber market, the natural variety was by far

[1] G. W. [illegible], "Future Trends In and Competition Between Natural and Synthetic Rubber". Paper prepared for the Expert Group Meeting on Future Trends In and Competition Between Natural and Synthetic Rubber, held in Vienna, 27-30 March, 1972, (UNIDO document ID/WG.110/3) (mimeo.).

BER INDUSTRY

by M. Fathy El Feky



the less "flexible" and less easily adjusted to bring supply and demand into balance.

It is certain that the market will continue to depend on synthetic rubber to fill the gap between natural rubber sales and total demand during the present decade as sales of new rubber are increasing at the rate of almost 5 per cent yearly and natural rubber production is moving ahead at a relatively slower pace. Natural rubber sales will continue upwards too however within the limits of its production capacity.

From the technical point of view natural rubber continues to hold a steady position in the manufacture of carcass and tread compounds for truck tyres. This is due to its unsurpassed properties of high resilience, low hysteresis and low heat build-up apart from its well known property of excellent "green tack" which is very important in assembling or building tyres.

The pattern of utilization of natural vis-à-vis synthetic rubber expressed as a percentage of total new rubber consumed, differs widely from market to market. SBR is the general all-purpose rubber in Europe, Japan and the United States, but it is not so in either India or Egypt where the natural variety still holds a strong position, as shall be demonstrated in the following examination of the rubber industry in Egypt.

Egypt's rubber industry

An examination of the rubber industry in Egypt shows that the main manufacturers of rubber products in this country can be classified as follows:

- Tyre products manufacturers (public sector).
- Non-tyre products manufacturers (public sector).
- Non-tyre products manufacturers (private sector).

While the first rubber products facility in Egypt dates back to 19[illegible], the first tyre production plant was established as recently as 1956. The private sector of the non-tyre products branch, which specializes mainly in footwear and diversified moulded household articles including some automotive parts, is relatively small owing to the difficulty of importing materials such as raw rubber and chemicals and limitations on importation of machinery and equipment. However this sector is expanding rapidly and is expected to increase its rate of expansion during the present decade.

The public sector in non-tyre products supplies the entire local market as far as footwear, rubber hose, rubber flooring and mats, latex products, transmission and conveyor belting etc. are concerned. In addition, large quantities of rubber products are imported, particularly medical equipment, special hosing, V-belts, and other products of a special nature. It is estimated that total imports of rubber products amount to 2,[illegible] tons annually.

Tyre products

Table 1 shows the output of different tyre products during the years 1967/68–1970/71.

TABLE 1. OUTPUT OF TYRE PRODUCTS

	1967/68	1968/69	1969/70	1970/71
Passenger car tyres	194 935	230 786	252 863	268 906
Truck tyres	133 795	134 904	155 904	160 402
Inner tubes	234 152	276 375	409 147	390 696
Bicycle tyres	453 315	453 300	286 896	342 900
Bicycle inner tubes	449 935	567 170	398 030	381 111
Motorcycle tyres	5 402	5 402	16 194	6 286
Motorcycle inner tubes	18 822	16 440	35 350	24 682

Table 2 shows the number of automotive tyres and tubes exported during the same period.

TABLE 2. EXPORTS OF AUTOMOTIVE TYRES AND TUBES

	1967/68	1968/69	1969/70	1970/71
Passenger car tyres	16 091	51 677	63 768	53 104
Truck tyres	407	9 985	14 576	11 423
Inner tubes	3 892	39 419	63 227	64 890

From these figures it is quite evident that for years a large proportion of the production of passenger car tyres was devoted to export while export of truck tyres was limited. But an examination of the actual local consumption of tyres and tubes based on vehicle population reveals the following:

Passenger car tyres. Passenger car density in Egypt is one of the lowest in the world: 4.4 cars per 1,000 inhabitants were in use in 1970. However although passenger car tyre production has always been below 300,000 units yearly, exports of this commodity represent 20-25 per cent of production.

This situation is changing rapidly owing to the rapid growth in private car ownership that has taken place during the past three years. Exports of passenger car tyres dropped in the year 1971/72 to about 30,000 units and the local market is suffering a shortage.

It is forecast that the number of passenger cars on the roads in Egypt will grow at a rate of 10 per cent annually over the next 10 years. Requirements will be about 500,000 units a year including 10 per cent for exports. Any export potentials or objectives beyond this share should be added to these requirements.

Truck tyres. Truck density has increased rapidly during the past few years as a result of a growth in local production of trucks, tractors and buses in addition to imports of trucks both by the public and private sectors. While it was possible in the period from 1960 to 1965 to export large quantities of truck tyres, in 1967 local production was less than total demand. Imports of truck tyres now amount to 80,000-90,000 units yearly (with about 10,000 units of local production being exported yearly to traditional export markets).

To forecast what the total market requirements of truck and tractor tyres will be in 1980, consideration must be given to the expansion plans of the local automotive industry, as this will be the main source of the vehicle population increase over the decade. An average growth rate of 10 per cent can be assumed, which indicates that total truck tyre requirements in 1980, including 10 per cent for export, will reach 650,000 units.

Non-tyre products

The public sector's share of this class of products represents the main share in output or production capacity. No accurate figures are available for production and import of rubber goods. However a good estimate is available for the last three years and from this a forecast for the next decade can be drawn up.

	Average 1969–1971	1975	1980
		Tons	
El Nasr Rubber Co.	4,000	7,000	10,000
Other public and private sectors	2,000	3,000	4,000
Imports	2,000	2,000	1,000

Rubber goods consumption

It can be seen from the above table that total consumption of industrial rubber goods in 1980 will amount to 15,000 tons. If the total weight of tyres and related products that it is expected will be produced in that year (about 35,000 tons) are added to this, total rubber goods consumption will be about 50,000 tons in 1980. Since Egypt's population in that year is expected to reach 42 million, per capita consumption of rubber goods therefore will be 1.2 kg. The per capita consumption of raw rubber in Egypt is discussed later in this study and comparisons made of present and forecast consumption with figures available for other countries of the world.

Present utilization of rubber

Natural rubber is by far the most widely used general purpose rubber in Egypt, since a large share of the country's rubber consumption is accounted for by the tyre industry and most of this by the truck tyre sector. In addition, the footwear industry and private sector producers of moulded household and automotive parts are more oriented towards the utilization of natural rubber.

Consumption of new rubber in 1970/1971 was estimated as follows:

	Tons
Natural rubber	5,000
Polybutadiene	1,200
SBR (including oil extended types)	3,000
Butyl	600
	9,800

This shows that natural rubber represented more than 50 per cent of total new rubber consumption. In the United States this percentage does not exceed 25 per cent and in Europe it never exceeds 35 per cent.

This situation will probably change gradually in favour of synthetics as it is expected that, together with the growth of total new rubber consumption during the present decade, there will be a corresponding growth in the utilization of synthetic material.

Forecast for 1980

A forecast for 1980 based on the growth expectations outlined above for the tyre sector, plans for expansion in the industrial goods sector and expectations of increased activities and effectiveness in the private sector, shows that total new rubber requirements may reach 30,000 tons (see table 5).

This means that total natural rubber requirements will be about 12,500 tons, representing 42 per cent of total new rubber. The remaining 58 per cent will be synthetic rubbers including butyl and other special types.

TABLE 5. FORECAST OF NEW RUBBER REQUIREMENTS IN 1980

(Tons)

	Tyre products	Non-tyre products: Public sector	Private sector	Total
Natural rubber	8,000	3,500	1,000	12,500
Polybutadiene	5,000			5,000
SBR	5,000	2,500	2,000	9,500
Butyl	2,000			2,000
Other synthetic types		500		500
	20,000	6,500	3,000	29,500

Per capita consumption of new rubber

Assuming that Egypt's population, which at present is about 34 million, continues to grow at the rate it has been growing for the past decade, i.e. at 2.5 per cent annually, in 1980 it will reach 42 million. Therefore, if per capita consumption of new rubber in 1970 was about 0.28 kg, by 1980, with an estimated total new rubber consumption of 30,000 tons, it will reach about 0.7 kg.

It can be seen from table 6, which shows per capita consumption of new rubber in a number of countries in 1960 and 1970, that, even in 1980, after more than doubling the per capita consumption for 1970, the figure for Egypt will still be considerably lower than the average per capita consumption in some developed countries today.

TABLE 6. PER CAPITA CONSUMPTION OF RUBBER IN SOME COUNTRIES, 1960 AND 1970

(Kilograms)

	1960	1970
United States	8.8	11.9
Canada	5.2	8.6
Australia	6.1	7.1
United Kingdom	5.7	8.2
France	4.9	8.1
Federal Republic of Germany	4.6	8.2
Italy	3.0	5.6
Japan	3.5	7.5
Netherlands	3.0	5.5
Brazil	0.9	1.3
India	0.1	0.2

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[illegible]

molecular configuration. This development made it possible to tailor make rubbers with specific combinations of properties.

This new class of elastomers is called solution rubbers and polymerization is achieved in a homogeneous solution of monomers and polymers in a hydrocarbon medium rather than in a hydrocarbon water emulsion. Among the first rubbers to be produced by the solution process were cis-polyisoprene and cis-polybutadiene. A new family of solution polymerized styrene butadiene and polybutadiene rubbers is being widely used now by the rubber industry. Solution polymerization has the advantages of regulation of the butadiene-styrene ratio, distribution of these monomers along the polymer chain together with the chemical configuration of monomers and control of long chain branching. The process results in rubbers of high purity with the following additional properties:

- Low odour and light colour which make them ideally suitable for making white, transparent or coloured rubber articles
- Low ash content with low water absorption
- High rubber hydrocarbon content

Characteristics of solution polymers

Technical literature available on some of the known solution polymers report that the following characteristics are to be expected from these rubbers:

- Fast cure rates, thus allowing a reduction of acceleration level in many instances
- High tolerance for fillers and oils, thus allowing great extension of compounds and the possibility of producing quality products at lower cost
- Excellent moulding properties
- Fast injection at low pressures together with good temperature resistance make them especially suited for injection moulding
- Low die swell and fast extrusion rates
- Outstanding ageing resistance
- Excellent aged adhesion properties
- High resilience and low heat build-up
- Low compression set
- Good tear resistance
- High abrasion resistance
- High resistance to crack growth

There is no doubt that solution rubbers will be used much more during the coming years and that they will open up an extensive field of research and investigation for the chemical and rubber industries.

Future of solution polymers

[illegible]

[illegible] solution polymers [illegible]

Conclusions

There is no doubt that controlled solution polymerization has opened up new [illegible] the rubber industry. There are strong indications that [illegible] with the future demand for styrene butadiene [illegible] polymers [illegible] solution polymers. These polymers hold great promise for further improvements [illegible] because of the possibility of controlling such parameters as monomer sequence, steric configuration, molecular weight distribution, branching, etc. [illegible] developing countries [illegible] synthetic rubber manufacture, the solution polymerization process offers more flexibility and less [illegible] than emulsion [illegible] rubber production.

Industrial Inquiry Service

Industrial Inquiry Service (continued)

What type of packaging is most economical?

[illegible]

Are there legislative restrictions to be observed in the choice of material?

[illegible]

[illegible]

[illegible]

[illegible]

Preparation of margarine involves the following steps:

- Selecting and preparing a suitable mixture of oils and fats
- Preparing the milk or water solution which forms the basis for flavour and aroma in the margarine
- Mixing or emulsifying the fat blend and water fractions in suitable proportions
- Cooling and crystallizing the emulsion
- Working and kneading the solid mass to give plasticity and body to the margarine
- Packaging the final product

[illegible]

margarine has not been obtained by culturing whole milk).

Flavour may be developed by incorporating ripened milk, i.e. milk that has been artificially soured by means of a bacterial starter culture. The same bacterial cultures that are employed to ripen cream for butter making are used to prepare milk for margarine manufacture. The desired flavour can also be obtained by adding a natural or artificial flavour concentrate. This is more usual in tropical countries.

A simple formula for margarine which can be tested is as follows:

	Pounds
Fat (prepared as above)	[illegible]
Skim milk (made with skim milk powder)	[illegible]
Salt (high purity flake; butter salt is generally used)	[illegible]
Soybean lecithin (food grade, as emulsifying agent)	[illegible]
Vitamin A concentrate (to give about 15,000 international units of vitamin A per lb of margarine)	1
Sodium benzoate (as preservative)	0.5
Starter distillate (or 1/10 oz diacetyl to give a butter flavour)	[illegible]

In small-scale experimental preparation, the fat, lecithin and vitamin A concentrate are mixed, heated to about 100°F, and mechanically blended to a uniform consistency. Milk, salt and sodium benzoate are then added and blending carried on until the mixture is again uniform. Finally, starter distillate is added and blending is continued for one or two minutes. The mixture, now probably at about 80°-90°F, is poured into containers and chilled as rapidly as possible. Starter distillate or diacetyl is added last to avoid loss of volatile flavour.

In commercial practice, the fat blend and milk fractions are mixed and emulsified in jacketed churns provided with paddles for stirring, or in continuous emulsifying machinery of various types. Dispersion of water globules in the fat must be of the proper fineness. If it is not, the margarine will be greasy in appearance and produce a fatty sensation in the mouth, or too coarse, water will leak from the margarine during storage. The emulsion may be cooled by feeding it onto brine-cooled rolls equipped with scrapers.

After cooling, the margarine is matured for a short period. It is then kneaded to consolidate and plasticize the loose crystalline mass from the cooling process and to work out any excess water. The margarine is allowed to temper for a time, then is fed into the hopper of a bulk moulding machine. This machine extrudes the product in a continuous bar of desired cross section and a cutter slices 1/4 or 1 lb blocks from the bar. As the blocks are cut off they are wrapped in parchment paper either by hand or by automatic machinery.

The latest type of margarine machine does the mixing, emulsifying, cooling and working all in one unit which also feeds the finished material direct into containers. The process consists essentially of forcing the mixture first through a system of internally refrigerated seamless steel tubes equipped with internal scraper blades, and then through a non-refrigerated "working" cylinder equipped with a rotating shaft or with projecting fingers. The most known of all margarine machines using the principle of cooling and plasticizing metal tubes is the "Vitameter" made by the Chemetron Corp. of Louisville, Kentucky, United States.

The simplest way to obtain a suitable fat mixture is to buy processed fat from a company experienced in its preparation, such as Blue Velvet, Australia, in Sydney. If this cannot be done, raw oils and fats must be alkali refined, bleached, hydrogenated to the desired melting point and deodorized. The oils most available in the Indonesian area (palm and coconut) should be suitable for this purpose if they are handled properly.

PROJECTS

UNIDO

Marketing has not as yet received the full importance it merits in the range of technical assistance activities undertaken by UNIDO in developing countries for the promotion of small-scale industries. Until now most requests in this field have been for expert advice on policies, programmes and incentives to promote small industry development or for help in identifying the types of production which small-scale industries could undertake. Requests of this type have been received primarily from the less developed countries.

In addition, expert help has been sought in establishing centres for promoting small-scale industry and institutions assisting small enterprises with an extension service to which local entrepreneurs can turn to overcome their technical and managerial problems. Other experts have advised governments on financial assistance for small industry development, yet others have helped in setting up industrial estates for small and medium industries.

Undoubtedly, some of the activities undertaken by UNIDO small industry experts in the less developed countries have on occasion touched on the question of market possibilities. Practically every industrial economist or industrial engineer who studied suitable projects for small-scale industry development had to take account of the potential market. However, this was done as a part of a task of broader scope and not as a specialized field of activity. More recently, some of the less developed countries have recognized the necessity of studying the market in a more fundamental manner. Thus there have been some cases of requests for experts to carry out market surveys and to identify market possibilities for small-scale production of new items.

Only in countries that are more advanced along the road of industrialization has a need been felt for specialized assistance in marketing. In countries where there are few small industries, the main concern is to set up factories and to increase output. Only when the number of small industries grows and competition develops is there a realization that the field of marketing is no less important than that of production and assistance is then requested to improve marketing efficiency. On the whole, however, the number of such requests has been relatively small. The requests have related both to the improvement of the distribution of products within the domestic market and to help in opening new export possibilities. As a rule, the items which are considered most important for developing overseas market possibilities are the products of the craft industries.

Assistance has been sought also in the improvement of the industrial design of the products. For the most part, such help has been sought for improving the external appearance and functioning of products of small-scale manufacture which have a high decorative content. Few, if any, developing countries have yet sought industrial design assistance for more utilitarian products.

There have been a few requests for assistance with special types of marketing problems, such as sub-contracting between large and small firms and help in creating a system of government procurement which would facilitate the sale of small industry products to the public institution market. With regard to sub-contracting, this type of help has been sought for the most part by the more industrially advanced of the developing countries. There are reasons to believe that assistance in government procurement could be suitable even in the least developed countries.

The following are some examples of assistance given by UNIDO in the marketing field over the past few years.

Africa

In Senegal a marketing expert was included in the team advising the government organization in charge of promotion and development of local small industries — SONEPI (Societe nationale d'etudes et de promotion industrielles). The expert studied the marketing possibilities of different items ranging from soft drinks and fruit juices to dried fish. He also looked into the possibilities of exporting these products. Some of these products are already being produced by local Senegalese firms while others are being studied as potential products for new small enterprises.

Another African country that has requested assistance for studying the market is Zambia. There a team of experts has been working for the past two years on the development of rural industries. When this project started, hardly any industrial enterprises owned and managed by Zambians existed in the country. They were all owned either by expatriates or by public corporations or jointly by both. A UNIDO marketing expert started recently to study the market with a view to appraising the feasibility of producing various items in the new small Zambian-owned enterprises being established in provincial towns.

In Togo, a marketing expert has been included in the team of experts assisting in the establishment of an industrial estate at Lome and helping the "Centre national de promotion des petites et moyennes entreprises", a government institution in promoting the establishment and development of local small industries. The marketing expert started work in mid 1971 studying the potential market and helping small enterprises to improve their marketing methods.

Caribbean area and Latin America

In Jamaica UNIDO provided for three years (1968-1971) a marketing manager for a public corporation called "Things Jamaican" concerned with the production and selling of the products of handicrafts, craft industries and small-scale industries. The expert also discharged for some time the duties of General Manager of this corporation. He gave assistance in promoting the sale of the products both to the local market and for export. He assisted in the search for new items and contributed to improving the quality and design of existing products in conformance with consumer taste in the country and abroad.

In some projects in South America marketing assistance has been requested as part of a programme of regional development. As an example may be cited the assistance being given by UNIDO in the north-west region of Argentina where an expert has been sent to Tucuman, a town which had suffered considerable unemployment in recent years due to the depressed state of the sugar industry. Although this had been the main industry of the area for generations, developments on the world market made the local sugar uncompetitive and a strong need was felt to create new employment opportunities for the local population. The expert is studying market possibilities for new small-scale and medium-sized industries that could be created to fill the employment vacuum left by the deterioration of the sugar industry. His findings should furnish the basis for planning new industrial development in this relatively underdeveloped region of Argentina.

In the State of Bahia in north-east Brazil, UNIDO is assisting a Development Centre established to promote and assist small and medium industries in the region. Among the team of experts working on this project is a market analyst who is carrying out market studies on new products under consideration for manufacture by new and existing small and medium enterprises in the area.

Asia

Asia is probably the area of the world where developing countries have recognized more the need for assistance in the marketing field. In Thailand, for example, in 1970 a UNIDO expert studied the problem of marketing—both national and international—of the products of small-scale industries and handicrafts. He prepared recommendations for the establishment of a marketing organization in the country which would undertake market surveys and research, disseminate information, improve product design, quality control, standardization and sales promotion. The expert also recommended the setting up of a comprehensive organization that would embody a handicraft promotion department, an industrial trade centre as well as an industrial product design centre. As regards the latter two centres, the expert proposed that the Government, in establishing them, should co-operate closely with the Association of Thai Manufacturers. While the Government has not so far implemented all the recommendations of the expert, it has followed up some of them and, in particular, has requested further expert help in the fields of industrial design and export promotion of products of small-scale industry and factory crafts.

In another country, Iran, UNIDO has been assisting an organization set up to provide technical and

PROJECTS (continued)

UNIDO

managerial assistance to small and medium industry throughout the country. The project has also furnished expert assistance in the establishment of an industrial estate at Ahwaz in southern Iran. The team of experts working on this project included a marketing expert who provided assistance, guidance and training for improving the marketing methods of small-scale industries. One of his special achievements has been a study of the public institution market as a source of orders for the products of small-scale industries. The expert has put forward a number of concrete proposals whereby the Government could create a suitable system and framework for enlarging the participation of the small industry sector as a supplier to the public market. A feature of interest is that the UNIDO marketing expert in Iran was assisted for a period by a young associate expert from Belgium who collected and analysed data on which market studies and surveys were based.

Middle East

In Turkey, UNIDO has assisted in the development of an industrial estate to provide facilities for relocation, organization and expansion of small industries. This project is located in the town and district of Gaziantep, a provincial centre in the south-east of the country. Among the experts comprising the team working on this project is a marketing expert with the special task of seeking out new markets for engineering parts and items produced in the area. This expert is also studying the items that are already manufactured in the area or that could be produced, that will be suitable for subcontracting to more developed industries in the central part of the country.

Subcontracting

Several relatively advanced developing countries have shown interest in expanding the volume of subcontracting between large and small industries. UNIDO has long recognized that subcontracting could be an effective means of expanding the range of activities of small-scale industries as well as proving of considerable benefit to larger contracting industries and to industrial development as a whole. With this view in mind a meeting was organized jointly with the Organisation for Economic Co-operation and Development (OECD) on the subject of subcontracting, in October 1969 in Paris. A number of studies and papers were prepared by the UNIDO and OECD secretariats and by participants from both developed and developing countries. At the meeting, an exchange of views took place on the experience of countries at all stages of industrial development. The report of the meeting has been widely circulated and has aroused considerable interest from many developing countries that have expressed a desire to receive assistance in this field.

Thus, in 1970 the Government of India requested UNIDO to provide an expert to assist in setting up subcontracting exchanges. Subcontracting exchanges were first established in Europe in the early 1960s and proved useful in creating the necessary contacts between the large industries looking for potential subcontractors and the small industries ready and able to receive orders from the larger contractors. The UNIDO expert sent out to India in 1970 was successful in establishing two such subcontracting exchanges in the major industrial centres of Madras and Bombay. Reports subsequently received indicate that these exchanges have been instrumental in expanding considerably the volume of subcontracting.

Early in 1971 the same expert carried out an assignment in Istanbul, Turkey where together with the local Chamber of Commerce, he assisted in establishing a subcontracting exchange similar to those he had helped to create in India.

A request pending is for the promotion of subcontracting in Venezuela. A number of other countries are still considering the submission of requests for expert assistance in this field.

Marketing and allied fields

In some cases assistance in marketing has been combined with other fields of specialization. As already mentioned, requests have been received for assistance in industrial design and in marketing of products. The request for assistance in industrial design in Thailand is of this nature. In other cases, marketing difficulties due to poor quality of the products have arisen, and assistance has been sought for improving quality control.

In one country—Uganda—an expert was provided to advise both on marketing and on financing for small industries. He was a member of a team helping in the development of small industries and in the establishment of an industrial estate at Kampala. The job description of this "industrial economist (marketing and finance)" included a combination of duties involving assistance in market surveys and improving marketing of small industry products, in addition to helping the Government, through an appropriate institution, to develop a financial assistance programme for small industry. However, experience showed that it was difficult, if not impossible, to find a single person having the experience and background suitable for carrying out both parts of the assignment. Not only did each part require different expertise, but it involved more work than could be performed by one person.

Although other attempts to combine marketing and finance have also been unsuccessful, this should not lead to the conclusion that there are no possibilities for providing marketing assistance as part of a wider form of assistance. Marketing is one of the fields of management and poor marketing is usually an indication of management difficulties on a wider front. Management assistance to small-scale industries may well incorporate assistance in the marketing field. Expert advice combining both areas has been provided several times by UNIDO and other international organizations. Thus, a specialized agency of the United Nations, the International Labour Organisation (ILO), has provided a number of experts to management projects in different countries which have included a specialist in marketing who has usually carried out extensive training programmes in this field. ILO has also assisted in the marketing of handicrafts both for the domestic and export markets. The Food and Agriculture Organization of the United Nations (FAO) has assisted in the marketing of agricultural and rural products and the United Nations Conference on Trade and Development (UNCTAD) has provided experts in export promotion including in some cases the export marketing of handicrafts.

Partnerships

A new scheme for promoting co-operation between industrial and developing countries in the field of small-scale and medium-sized industries entitled "Partnerships" has been proposed by UNIDO as a means of assisting in the development of small enterprises in developing countries in Africa. Some of the forms of partnerships proposed involve the promotion of domestic marketing. It is suggested for instance that partnerships may create subcontracting arrangements for the production of parts and components by an enterprise in the developing country on order of the foreign company. Partnerships might involve assistance in marketing products manufactured by a joint venture; they may also cover licensing and franchising commitments permitting the marketing of a foreign company's product locally produced under the brand name of the parent company. If this scheme is successful it could in the course of time raise considerably the level of marketing of small enterprises in some developing countries.

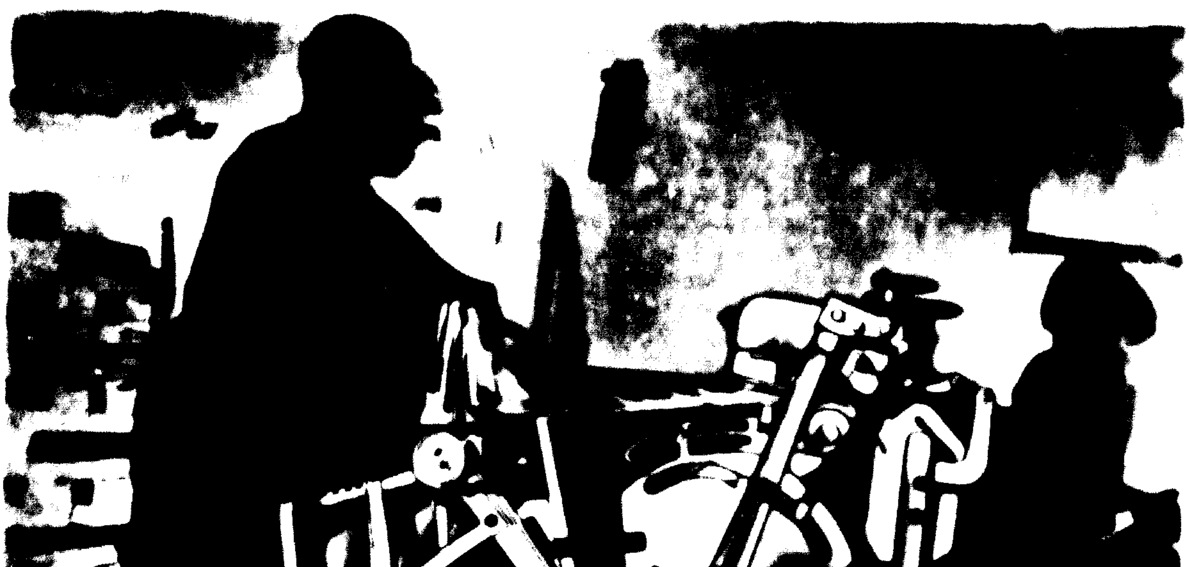
Conclusion

UNIDO feels that there is scope for increasing the number and the type of technical co-operation projects relating to the marketing of small industry products. In countries at an early stage of development help might effectively be given for carrying out market surveys or analyses of market opportunities for new small industries. In more industrialized countries, assistance might tend to improve the marketing of small industry products in all its aspects including allied fields such as subcontracting, industrial design and quality improvement.

There is also scope for increasing the number of fellowships in marketing, which has until now been negligible. A greater emphasis on marketing in the programmes of training centres for small industry development, both in the industrial countries and in the extension centres in the developing countries, would be desirable.

SAFICA – in pictures

Quality control of printed material after folding printing machine in background



Semi-automatic stitching and folding operation pile of books in background await trimming

SAFICA aids Ivory Coast Education Programme

Close-up of wire stitching school books, prior to trimming and despatch at SAFICA, Abidjan

The "Société africaine de fabrication et d'impression de cahiers" (SAFICA) in Abidjan, Ivory Coast is one of the first printing and book binding works to be established in that country. It came into being to meet the growing demand for school books and stationery caused by the mass education programme in the Ivory Coast.

The "Office de promotion des entreprises ivoiriennes" (OPEI) suggested the idea after conducting a techno-economic study and in 1968 the "Société d'études et de réalisations industrielles" (SERI) of Renault Engineering, France was asked to implement the results of their findings.

Construction began in July 1968 and the plant went into full production less than one year later. Since then two similar plants have been set up in Brazzaville, Zaire, and Douala, Cameroon. These plants will shortly be adding an envelope manufacturing line. A third plant to be built in Bangui, Central African Republic, will commence production in 1973.

Layout of SAFICA printing and book binding works, Abidjan

BOOKS

[illegible] function is inadequate.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Handbook of Precision Engineering, Volume [illegible]

[illegible]

Volume [illegible] [illegible]

Volume [illegible] [illegible]

[illegible]

Meetings

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New York, New York 10017

United States of America

Articles to be considered for publication, comments on material published and suggestions for topics to be covered should be sent to:

The Editor
Industrial Research and Development News

United Nations Industrial Development Organization

P.O. Box 300

A-1400 Vienna

Austria

[illegible]

75.04.09