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UNIDO'S MULTI PURPOSE PILOT PLANT CONCEPT

Report of the Expert

Christian R. Noe

Vienna, February 1987

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THE MULTI PURPOSE PLANT CONCEPT

1. UNIDO'S ACTIVITIES IN THE FIELD OF PRODUCTION OF PHARMACEUTICALS - THE GENESIS OF THE MULTI PURPOSE PLANT CONCEPT

Health care is an important factor in human societies. In this respect it is not surprising that pharmaceutical industry is one of the most sensitive areas among industrial activities.

UNIDO has endeavoured to assist developing countries in setting up and improving their pharmaceutical industries.

Pharmaceutical industry comprises the following main sectors: pharmaceutical formulation, pharmaceutical chemicals, fermentation, vaccines and products based on natural resources. These subsectors are correlated to each other and it can be said that nowadays in most of the countries of the world at least one or more of these activities is carried out.

A more detailed analysis concerning developing countries reveals that formulation industry has been successfully established in many countries whereas pharmaceutical chemicals industry can be found in only a limited number of countries.

This situation is rather disappointing because formulation industry is almost completely dependent on pharmaceutical chemicals industry. At present in several countries complete dependence on imports of pharmaceutical chemicals has restricted the implementation of the national health care programmes.

One of the main reasons for the present situation of very limited pharmaceutical chemicals industry in developing countries is certainly the dynamic character of the pharmaceutical industry itself with its rapid development and change of products.

Other factors frequently found are a limited market size, which does not justify entering into pharmaceutical chemicals production by setting up a single line plant. Furthermore lack of local know how and infrastructure required for this branch of industry and finally investment aspects.

UNIDO has commenced its activities in this specific field already several years ago and both in the First and in the Second Consultation on the Pharmaceutical Industry in Lisbon (1980) and especially in Budapest (1983) the idea of starting local manufacture of pharmaceutical chemicals in a "multi purpose plant" has been discussed and promoted by UNIDO (see also "Multipurpose Plant for Production of UNIDO Essential Drugs Based on Raw Materials and Intermediates" - ID/WG.393/19; 7 November 1983). In the meantime, apart from this theoretical approach project activities have started which have resulted in the erection of one multi purpose pilot plant in Cuba, which is now already in operation. Another multi purpose plant project in Iran is under construction. Finally preparatory studies concerning this topic have been carried out in several other countries such as Brazil, Algeria and Venezuela.

Based on its experience from the variety of activities in this field UNIDO worked out a comprehensive multi purpose plant concept, and takes the opportunity to present this proven concept in this paper. The strategy of this concept is to use a flexible and versatile approach in order to match the dynamic character of the pharmaceutical industry.

2. CHARACTERISTIC FEATURES OF A MULTI PURPOSE PILOT PLANT

Although the term "multi purpose plant" itself is well known, there are divergent opinions as to what it should mean. The multi purpose plant as presented by UNIDO is not just meant to be a production unit for pharmaceutical chemicals, but it represents rather a concept for establishing local production of pharmaceutical chemicals, which exhibits some typical features. To avoid misunderstanding, first of all the main characteristic features of the multi purpose plant concept will be presented.

2.1. PRODUCTION RANGE AND FLEXIBILITY

As the name indicates, the most obvious feature of a multi purpose plant is the fact that not one but several pharmaceutical chemicals can be manufactured in one plant by chemical synthesis.

The equipment of a multi purpose plant is chosen in a manner which allows production of a variety of different synthetic pharmaceutical chemicals without requiring additional investment for effecting a change in product mix.

The lay-out will allow a variety of unit operations and unit reactions to be carried out thus creating technological know-how in the recipient country.

In the standard case pharmaceuticals which are obtained by fermentation processes are not included in the multi purpose plant product range.

2.2. CAPACITY AND SCALING-UP OF PRODUCTION

There are great differences from product to product concerning the scale in which industrial production of pharmaceutical chemicals is economical. The scale in which production takes place in a multi purpose plant is however more or less determined

by the requirements of the multi purpose plant concept, such as flexible lay out or scaling up facilities.

Compared to a single line plant the capacity of a multi purpose plant to produce one specific pharmaceutical chemical is rather limited. With respect to the fact that not one but several products are to be manufactured in the same plant, a production scale which is too big would create too many additional requirements concerning lay out, equipment and production organization.

For this reason it is foreseen to limit the maximum reactor size to 1 m^3 in the case of smaller multi purpose plants primarily geared to research and development activities and to a size of 3 m^3 for great multi purpose plants having more emphasis on production activities.

This limited scale of production is to be considered, when choice of products and technologies for their production is made.

2.3. ADJUSTED SET OF TECHNOLOGIES

Together with the installation of a multi purpose plant a set of technologies for the production of pharmaceutical chemicals according to the requirements of the recipient country is provided. Choice of technologies and plant lay out is adjusted to each other to secure envisaged production output from the beginning of operation of the plant.

At a later stage also technologies for the production of other pharmaceutical chemicals which may be either purchased or developed in the plant should be introduced.

2.4. TRAINING FACILITIES

The multi purpose plant concept with its mix of production and R&D activities provides an ideal opportunity for local training in the field of pharmaceutical and chemical synthesis. Beyond the training in production, the multi purpose plant can also be a suited place for training in the fields of plant operation, administration and quality control.

2.5. RESEARCH AND DEVELOPMENT ACTIVITIES WITH SCALING UP AND BACK INTEGRATION OF TECHNOLOGIES

It is often assumed that research in the field of pharmaceutical chemistry is consistent with development of new pharmaceutical chemicals. As a matter of fact this type of research is not foreseen within the multi purpose plant concept.

As far as a multi purpose plant is concerned, research and development (R&D) activities mean first of all developing know-how and capability to carry out synthetic reactions on an industrial scale. These activities will first of all result in achieving the capability to scale up reaction processes from laboratory scale to the production scale or at least to a scale which allows transfer to single line production.

Therefore, the lay out of the equipment of a multi purpose plant will comprise units in a suited series of different production scales to allow scaling-up of reactions to required levels. This is most important with respect of transfer and development of technologies.

Specific adaption of production technologies according to the specific situation in the country concerning raw materials, other

chemicals, climate or other factors constitute another important factor in R&D in a multi purpose plant.

Within this aspect the so-called back integration of technologies is of great importance, which means that approved production processes which start from a later step intermediate are expanded in such a way that production starts from a more basic raw material.

The impact of R&D activities may be summarized as follows:

Direct R&D activities: Process development for large scale production
Process improvement in connection with trouble shooting
Scaling up
Back integration of technologies

Indirect R&D activities: Development of new technologies for known pharmaceutical chemicals
Development of new pharmaceutical chemicals
Synthetic transformation of selected natural products to be used as pharmaceutical chemicals
Unpredictable impact

It may be expected that every well planned multi purpose plant project will successfully fulfill the direct R&D activities. The degree to which it will promote indirect R&D activities will certainly depend on the scientific and industrial standard of the recipient country.

2.6. LINKAGE TO DOMESTIC FORMULATION INDUSTRY AND RESEARCH INSTITUTIONS

A multi purpose plant should not only be linked to domestic formulation as well as to pharmaceutical research institutions, but it is in fact aimed to be in itself the link between domestic formulation industry and research institutions.

In contrast to the situation concerning production of pharmaceutical chemicals, formulation industry of high standard may be frequently found in developing countries. It is obvious that the linkage to such domestic formulation industry is of great importance, because the production output of the multi purpose plant will be the raw material for formulation industry. Therefore, it seems advisable to integrate formulation industry at an early stage into the planning of the product mix to be manufactured in the multi purpose plant. An even more promising approach is to set up the multi purpose plant within the frame of an existing pharmaceutical formulation organization.

As a matter of fact basic pharmaceutical research is carried out in many countries of the world. This research is mainly university research and is usually aiming at new chemical compounds with potential pharmaceutical activity. It is as a rule carried out on a very small scale and frequently, there is no direct connection with local pharmaceutical industry to make use of the results.

Considering these facts it may be stated that both formulation industry and basic pharmaceutical research are frequently well established in developing countries, sometimes both of a high standard. Surprisingly there is however a gap between these two activities in the field of pharmaceuticals. As a rule there are no existing facilities to carry out local production of pharmaceutical chemicals and as a consequence there are no related industrial research and development activities. Existing local institutions which carry out basic pharmaceutical research

and which might easily assist in such activities are not even in a position to transfer the results of their own research work to local industry.

It is exactly the multi purpose plant concept that helps to fill this gap and to give the existing R&D potential an active part in industrial activities in the field of pharmaceuticals. Scaling up facilities found there are the connection between industrial production and basic pharmaceutical research and give an impetus for cooperation to both sides.

3. PURPOSE AND OBJECTIVES OF A MULTI PURPOSE PLANT FOR PRODUCTION OF PHARMACEUTICAL CHEMICALS

3.1. ESTABLISHING A NEW BRANCH OF PHARMACEUTICAL INDUSTRY

Transfer of technology is always very sensitive and risky, whenever a new branch of industry is concerned. The main aim of the multi purpose plant concept is to establish the branch of chemical synthesis of pharmaceutical chemicals on a broad and flexible basis creating manufacturing facilities and providing a first set of technologies together with R&D and training opportunities.

3.2. CREATING KNOW-HOW IN PHARMACEUTICAL CHEMICALS PRODUCTION

One characteristic feature of the multi purpose plant is that together with the plant a set of technologies is transferred which allows versatile operation of the plant from the beginning of its operation. Speaking of know-how there is in the first instance the know-how which is transferred together with these production technologies. On the other hand there is the know-how potential which is created from experience within the operating multi purpose plant itself. The fact that the plant has also a considerable R&D and training function will help to establish and create this new type of know-how on a broad basis.

3.3. CREATING PRODUCTION CAPACITY FOR PRODUCTION OF PHARMACEUTICAL CHEMICALS

Certainly the most obvious objective of the multi purpose plant concept is to create production capacity for manufacture of pharmaceutical chemicals. It is a specific advantage of the lay out of a multi purpose plant that it is as well suited to provide additional capacity for small scale production and R&D within a

highly developed pharmaceutical industry as to be a first step into production of pharmaceutical chemicals in the recipient country at all. Therefore the plant itself will represent a useful unit at any of the stages of development of local production of pharmaceutical chemicals.

3.4. A POLICY TOOL FOR DEVELOPMENT OF PHARMACEUTICAL INDUSTRY CREATING INDEPENDENCE

Considering all the factors mentioned before, above all flexibility in production range and capacity, it can be seen that the multi purpose plant concept is an efficient policy tool for development of the pharmaceutical industry of the recipient country.

Any new production activity disturbs the existing market for a product and as a rule the market will react. Sometimes such a reaction may even render a production uneconomic e.g. in cases of the reaction of the market being local decrease of product price or increase of raw material price. The main advantage of the multi purpose plant compared to a single line plant is that it is a flexible production facility so that the plant is not dependent on only one product and not even totally dependent on the set of products transferred at the beginning of plant operation. It may be expected that after some time of operation a broad production range can be performed in the plant, so that quick answer can be given to reactions and requirements of the local market.

In many countries the health care system is an area of first priority with a lot of activities carried out in the government sector. Purchase of pharmaceuticals frequently represents a sensitive system, e.g. in countries with foreign exchange problems. Local production facilities will reduce dependence from the foreign market, by replacing international purchase by local production or at least by providing opportunity and choice to buy

an intermediate or a raw material instead of the finished pharmaceutical product whenever economically advisable.

4. PREREQUISITES FOR SETTING UP A MULTI PURPOSE PILOT PLANT

4.1. TECHNOLOGICAL STANDARD OF THE COUNTRY'S PHARMACEUTICAL INDUSTRY

The multi purpose plant concept concerns the basic branch of pharmaceutical industry which provides raw materials for the formulation industry. Therefore it seems advisable to initiate such activities only in countries with an existing formulation industry, which will use the products to be manufactured in the multi purpose plant.

Economic operation of any plant will depend on a sufficient size of the potential market. In the case of small countries it seems advisable to start multi purpose plant projects rather on a regional basis jointly with neighbouring countries than try them on a too limited scale. In any case an approach seems plausible in which the capacity of the first multi purpose plant to be set up in a country is not supposed to satisfy a major percentage of the total local demand of pharmaceutical chemicals. The capacity should be sufficient to allow economic operation of the plant, but the main aim of the multi purpose plant concept is to be a first step into a new area of pharmaceutical industry and to create know-how, R&D and training facilities as well as other follow up activities such as further plants for production of pharmaceutical chemicals.

Starting materials for production of pharmaceutical chemicals may be intermediates, basic chemicals or natural products. While as a rule existing local manufacture of intermediates may not be expected in developing countries, basic chemicals and natural products to be used as starting materials may be frequently available. Such a situation might create a welcome connection between local chemical and pharmaceutical industries. A careful analysis of the specific local situation with this respect seems advisable to make use of local sources to an extent as great as possible.

4.2. PRODUCTS AND TECHNOLOGIES

4.2.1. CRITERIA FOR CHOICE OF PRODUCTS

The choice of products as well as production technologies to be applied in a multi purpose plant depend to a large degree upon several factors which in several cases are correlated to each other. In the following a list is given for the main criteria which should be applied in setting up a list of products to be manufactured:

- Requirement of the country's health system
- Requirement of the formulation industry
- Economy of production
- Availability of technologies
- Suitability of technologies for the multi purpose plant
- Patent situation
- "Technology transfer"-value of the technology

The most important factor for choice of a product is the factor of requirement of the country's health system. As a rule this requirement assessment will result in a first and probably too long list of products to be manufactured in the multi purpose plant.

Further evaluation should start from this list and reduce it according to the parameters given above.

Some specific parameters specifically applying to the multi purpose plant concept are the following:

Pharmaceutical chemicals obtained from fermentation processes are of utmost importance for the health systems of all countries and will appear in each list of products based on the requirement of the country. Even so it seems advisable not to consider such products but to restrict the use of the multi purpose plant to products of chemical synthesis, which do not require fermentation

steps. Although there are chemical reaction steps in the synthesis of most of these products which might be carried out in a multi purpose plant in principle, a dependence on the fermentation intermediate will remain and future back integration to basic starting materials cannot be carried out.

Another group of pharmaceutical chemicals not to be considered are low price products, such as acetylsalicylic acid or paracetamol etc.. These products are usually manufactured in bulk quantities in large scale industrial processes. With such compounds it might happen that the raw material price for small scale production could have about the same price as the end product. Therefore it seems difficult to justify the transfer of such compounds within the first set of technologies in a multi purpose plant, unless it is required by a specific situation.

A third parameter of elimination which is typical for the multi purpose plant is the factor of low "technology transfer" value. The production of such compounds would not create significant know-how with respect of unit operations or unit reactions. With respect of the fact that some of such simple production technologies might be economically feasible, however such low value technologies might be considered as interesting targets for first attempts towards local know-how development.

4.2.2. CRITERIA FOR CHOICE OF PRODUCTION TECHNOLOGIES

Of course availability of a technology is a prerequisite for a product to be chosen for transfer. Usually more than one production technology exists for the manufacture of a pharmaceutical chemical. Also degree of sophistication and the value of such technologies show considerable variations. The choice of products and technologies for a multi purpose plant depends on several factors, some typical are the following:

- As a rule lay out of a multi purpose plant does not allow

continuous processes, such as frequently used in single line production. Batch technologies are therefore applied.

- The typical multi purpose plant technology can be carried out in standardized equipment, which can also be used for manufacture of other compounds.
- The requirement of a multi purpose plant is not one but several technologies. As a rule it is almost impossible to finance a set of expensive technologies, last not least also because of the limited production capacity of such a plant.
- The specific patent situation of the recipient country has to be considered.
- Concerning the cost of technologies there can be great variations due to the degree of sophistication of the specific technology and the market price and lifetime of the product. At present it may be estimated that an illustrated minimum price for a typical multi purpose plant technology would be about US\$ 30.000.-- to 40.000.-- per pharmaceutical chemical.

4.3. STARTING MATERIALS

4.4.1. BASIC CHEMICALS

Of course local availability of basic chemicals is an important factor in planning a multi purpose plant, not only because the choice of production technologies and the economic evaluation of the project will be influenced by this situation, but also because a complete lack of local production of basic chemicals would indicate a situation of low development of chemical industry in the recipient country. This would make set up and operation of a multi purpose plant more difficult because of the lack of infrastructure.

4.4.2. INTERMEDIATES

Synthesis of pharmaceutical chemicals frequently does not start only from basic chemicals but makes use of intermediates. These intermediates are available on the international market, such as the pharmaceutical chemicals themselves. As a rule it may not be expected that there is local production of specific intermediates for pharmaceutical chemicals in the recipient country.

One objective of the multi-purpose plant concept is to create flexibility. Thus the question might arise whether it might be useful to replace an imported end product by an imported intermediate. The answer is positive, because first of all lower costs required for intermediate imports will help to save foreign exchange. Secondly there is an increased flexibility, because consideration of alternative use of the intermediate enables better choice from the international market. Thirdly an impact is given to back integration of technologies and the intermediates themselves might become interesting products for the chemical industry.

4.4.3. NATURAL PRODUCTS

In many developing countries, especially in tropic countries, a great variety of medicinal plants and natural products to be used for pharmaceutical purposes can be found. Frequently there are also some research and other activities in this field, as a rule however there are no facilities to carry out synthesis of larger quantities of pharmaceutical chemicals starting from isolated natural products. While plant extraction itself does not constitute a standard part of the multi-purpose plant concept, chemical transformation of natural products certainly does fit into the concept. The multi-purpose plant is in a position to enable local production of such compounds on a commercial scale.

It may however not be expected that activities connected with local natural products might constitute a significant part of production in the first phases of a multi purpose plant project.

4.4. PLANT SITE AND PRODUCTION FACILITIES

Although a typical multi purpose plant carries out pilot plant and R&D activities, its appearance and prerequisites are clearly those of an industrial plant.

There is significant requirement for space (production facilities, laboratories, administration, storage rooms, tank farm, effluent treatment), energy (electricity, steam) and water (process water, cooling water).

With respect of the production activities involving chemicals environmental measures (effluent, exhaust air and chemical waste treatment) will be of great importance.

Although in every case a multi purpose plant will receive a layout that will meet the requirements of the specific project, some figures are given to allow an impression of the space requirements of a typical multi purpose plant.

Total reactor capacity:	30 m ³
Plant area:	10.000 m ²
Production area:	1.000 m ² (height of production area 9 - 10 m to allow required service floors)
Storage area:	600 m ²
Underground Storage:	1.000 m ²
Service Facilities:	500 m ² (administration, laboratories)
Utilities and	
Effluent treatment:	500 m ²

Concerning the plant site it is recommendable to attach the multi purpose plant to an existing formulation unit where feasible. In

this case it may be expected that some of the infrastructural and administrative requirements are already given in advance, so that investment may be saved. The erection of the multi purpose plant might provide a good opportunity to upgrade the standard of the existing plant infrastructure.

With respect to planning and erecting the plant, setting up the multi purpose plant as a separate unit in an industrial area would even be a preferable approach.

4.5. EQUIPMENT

The equipment of a multi purpose plant is determined by several characteristic features. Firstly, scaling up facilities must be given that means that the lay out of the plant has to allow reactions in a series of different scales. Secondly, a great variety of unit operations and unit reactions should be feasible in the plant that means that careful choice has to be made with respect to versatility of equipment. Finally, research and development activities require reserve capacities and sufficient analytical equipment.

4.5.1. EQUIPMENT FOR SYNTHESIS

The typical lay out of the synthetic equipment in a multi purpose plant will comprise reactors from a size of 100 l to a maximum size of about 3000 l. (Considering the required glass equipment the scale of synthesis will even start from about 1 l.) Appropriate choice has to be made concerning the material of the equipment. Steel and enamelled steel reactors are equally required to allow a broad range of reaction conditions. The rest of the equipment - above all: centrifuges, dryers, filters, pumps, condensers, tanks, vessels, receivers and balances - will be determined by the choice of processes and reactors.

4.5.2. EQUIPMENT FOR RESEARCH AND DEVELOPMENT

Equipment for research and development in a multi purpose plant to a great extent means just leaving reserve capacity in the normal equipment to carry out scaling up of new technologies and improving existing technologies. Beyond that, equipment for research and development also means that there has to be small scale glass equipment to carry out reactions in a small inexpensive scale either for trouble shooting or for technology development. Since investment required for equipment in this scale is rather limited special care should be taken with regard of obtaining a great versatility of unit operations.

4.5.3. ANALYTICAL EQUIPMENT

It has to be borne in mind that analytical equipment which is needed for quality control and technology development in a multi purpose plant requires considerable investment. Again careful choice has to be made to meet the high standard quality requirements of pharmaceutical industry.

4.6. ENVIRONMENTAL ASPECTS

Environmental aspects are of increasing importance in chemical and pharmaceutical industries. As a rule Government regulations exist or may be expected in near future which will have a significant influence as well on plant site as on lay out and investment.

As far as environmental installations are concerned there are three main areas of concern: exhaust air, effluents and chemical waste.

As far as exhaust air is concerned installation of scrubbers connected to an efficient exhaust system will be required.

As far as chemical wastes are concerned installation of an incinerator is recommendable or even required, if there is no general system for removal of chemical waste in the country.

Concerning effluent treatment it is without any doubt necessary to erect an effluent treatment plant. This plant will certainly require the greatest part of the funds used for environmental measures.

The extent to which investment for environmental purposes is required will to a great extent depend on Government regulations. Therefore careful observation of all pertaining legislature is required already at an early planning stage.

4.7. SKILLED MANPOWER

To operate a multi purpose plant there is a considerable requirement for skilled personnel. The following functions are required: plant director, production manager, finance and administration manager, R&D and quality control manager, mechanical engineer, production supervisors, technicians for R&D and quality control, maintenance technician, electrical technician, chemical operators, laboratory operators, maintenance personnel.

Availability of personnel having the required training will certainly depend on the general educational standard of the recipient country on the one hand and on the presence of related industries, such as formulation or chemical industries, on the other hand.

Together with planning of a multi purpose plant required training of personnel should start. It cannot be expected that all of this training can be carried out locally. Therefore arrangements should be met to carry out training abroad, if possible in the

facilities of the technology suppliers or industrial units of similar structure.

Considering the variety of functions to be carried out, the multi purpose plant itself at a later stage may become an almost perfect versatile training facility to serve the requirements of local pharmaceutical and chemical industries.

4.8. MANAGEMENT AND PRODUCTION ORGANIZATION

It is obvious that a multi purpose plant such as any manufacturing unit requires a management and production organization. It has however to be pointed out that in the case of a multi purpose plant with its multiple production lines and changing production programme rather sophisticated production organization and flexible management are required.

Although the multi purpose plant may be considered to be only a pilot plant, there will be considerable costs for running the plant, which will require a corresponding production output. All aspects of production, such as financial planning, production planning, costing and pricing should be carried out, as if the unit were a purely manufacturing plant. It is recommendable to set up a production organization based on the use of computers, which has been proven to be a successful approach in small scale manufacturing units.

4.9. EXECUTING PARTY

It is obvious that the question of "who is going to make it" is of important in every project. Roughly seen depending on the country three different situations are found concerning pharmaceutical industries: government sector pharmaceutical industry, private sector pharmaceutical industry and a mixed system in which both types are found. Concerning the

executing party for a multi purpose plant it has to be borne in mind that it should be closely related to the local formulation industry. Therefore it seems as a rule advisable that the executing party to set up the multi purpose plant should be within the same sector as the formulation industry which will use its products.

As a matter of fact direct participation of the local formulation industry in such a multi purpose plant project is a desirable approach.

4.10. INVESTMENT AND ECONOMIC ASPECTS

It is not easy to give a definite answer concerning investment required to set up a multi purpose plant. An estimated amount of US\$ 1.000.000 might be considered as a minimum investment to have available all the typical features of a multi purpose plant at a sufficient scale and to be in a position to reach the objectives of the concept. An optimum size plant with respect of the requirements of the presented concept having considerable production output would however rather require an estimated investment of about US\$ 5.000.000.

Return of investment is a most important parameter in any production unit. Speaking of the multi purpose plant concept it is therefore very important to be clear from the beginning that the typical multi purpose plant is not merely a production unit but carries several additional functions, such as R&D or training activities. The extent of dedication of the plant to R&D activities on the one hand and production activities on the other hand should be clear already in the planning phase. Doing this the following limitations should be borne in mind:

R&D in a synthetic scale as present in a multi purpose plant is very expensive. It is one of the basic ideas of the concept to enable such activities by carrying out at least some minimum

production activities to finance R&D. Therefore a pure pilot plant character without any economic production activity seems difficult to establish and expensive in operation in such a big scale.

On the other hand there might be a position to use the multi purpose plant only as a production unit. Although such an approach would be feasible in principle, the multi purpose plant should in this case however not be seen simplified as a magic box that manufactures economically any choice of pharmaceutical chemicals in one plant instead of only one product as in a single line plant. A required minimum scale of economic production will exclude manufacture of many pharmaceutical chemicals in this case.

The multi purpose plant as presented in the UNIDO concept exhibits a layout to enable both versatile production and R&D. In the UNIDO approach flexible lay out of the plant will reduce the economic risk of the decision to manufacture one specific product. A decision to set up a merely producing multi purpose plant would require a different approach to the project and a different layout of the plant.

Bearing these things in mind it becomes clear, why an early decision is required already at the stage of planning defining the partial dedication of the plant for both R&D and production activities.

5. UNIDO'S EXPERIENCE IN MULTI PURPOSE PLANT PROJECTS

Apart from studies there are two projects which have proceeded further. One of these projects has resulted already in an operating plant and the other project is under construction.

5.1. THE CUBA PROJECT

The first project of a multi purpose plant was carried out in Cuba. The main contractor was an Indian firm. Technologies and most part of equipment came from Indian sources. The project was a case of south-south cooperation. The positive result of this project is also illustrated by the fact that still now in the phase of operation of the plant there is close and friendly cooperation between the Cuban and the Indian partner.

5.2. THE IRAN PROJECT

Another project of a high capacity multi purpose plant is at present under construction in Iran. In this case the main contractor is a Hungarian firm. There is a partnership with Austrian firms in this project so that the project is a case of a south-north (Europe east)-north (Europe central) cooperation.

6. UNIDO'S ROLE IN MULTI PURPOSE PLANT PROJECTS

In the present report an attempt was made to present the UNIDO multi purpose plant concept with its characteristic features, its purpose and objectives and the requirements to establish such a plant. It may be seen from this paper that a project to set up such a multi purpose pilot plant is a multi facet project containing many specific factors, which have to be considered, and requiring a high degree of coordination of activities.

UNIDO has had the opportunity to gain experience in this field regarding all aspects of such a project from basic considerations to operation of the plant. UNIDO is ready to provide information and technical assistance in assessment, planning, setting up and running of such a plant and is also ready to take part in coordination of such projects and will also provide long term technical assistance. It is the wish of UNIDO to assist developing countries in making the first step into this important branch of pharmaceutical industry.