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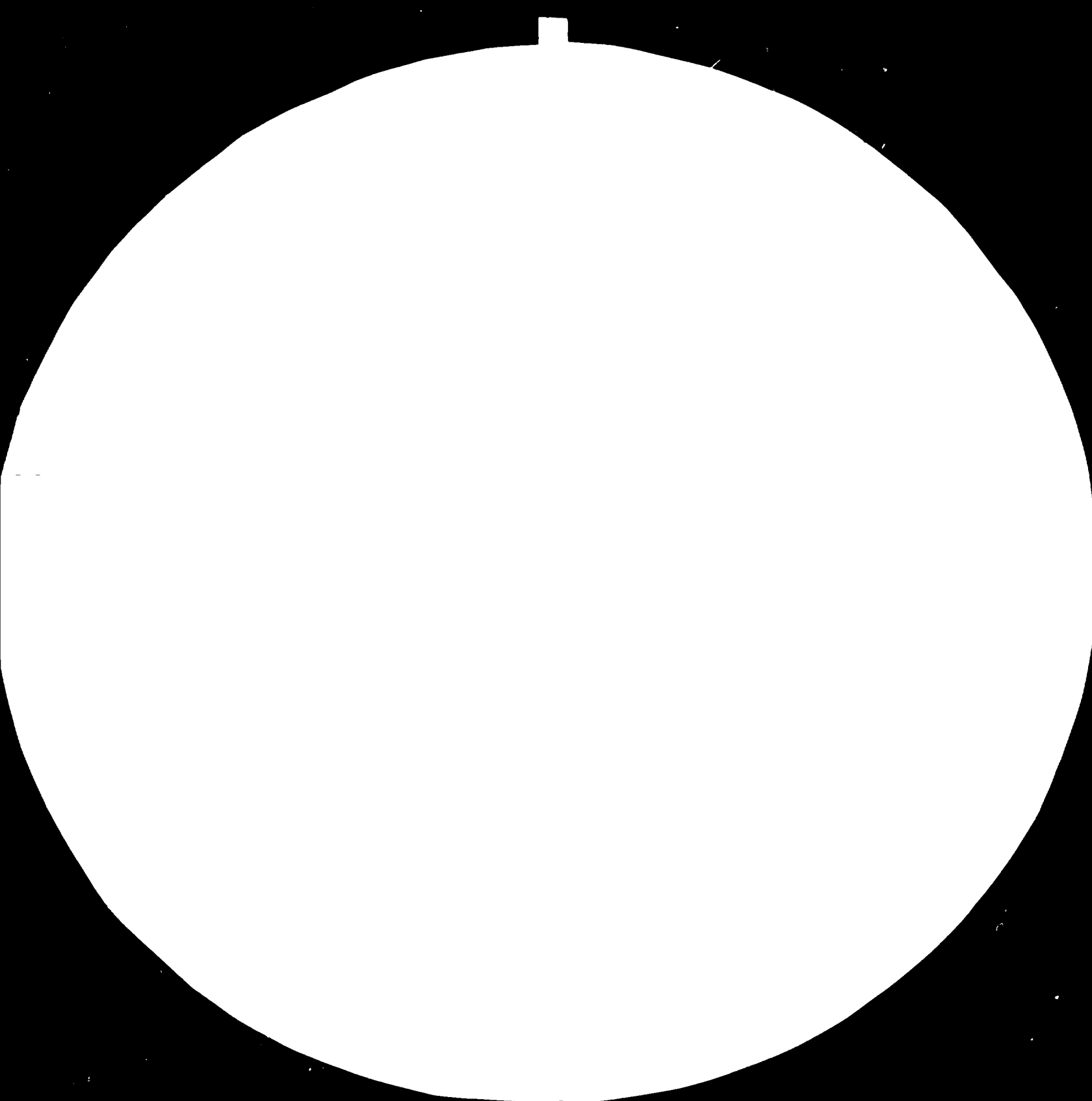
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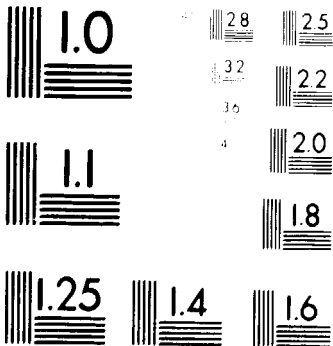
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PRODUCT DEVELOPMENT AND DESIGN PROBLEMS
CONNECTED WITH MULTI-PURPOSE AGRICULTURAL MACHINERY PLANTS .]

by

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PRODUCT DEVELOPMENT AND DESIGN PROBLEMS CONNECTED
WITH MULTIPURPOSE AGRICULTURAL MACHINERY PLANTS

Production of any product intended for an open market, and consequently production of machinery and equipment for agriculture, requires the answering of the following questions:

- what is to be produced
- where are the potential customers
- in what quantities and by what time are those products to be manufactured
- how and in what way is the production to be organized.

A Multipurpose Machinery Plant is usually intended for the production of a wide variety of products in small quantities. The plant equipment includes universal machine tools such as lathes, universal milling machines, shaping machines, boring machines, sheet metal working machines, welding equipment, etc. Only a few plants have their own heat treatment department, toolroom or quality control and very rarely their own Product Development and Design Department with a Prototype Shop.

In principle, Multipurpose Plants have the capacity for the wide-scope production of simpler agricultural machinery and equipment in small series. The stricter the requirements for parts interchangeability and standardization, the greater the problems at a higher technical level encountered by factory management and technical departments in order to organize the production in such a way as to meet such requirements.

The Multipurpose Machinery Plants are in most cases, especially in developing countries, manufacturing a large number of various products for the market. The technical preparation of the production is usually at a relatively low engineering level. The production problems are normally solved on the spot when they arise during the production cycles. Under such circumstances the question of product quality control is often neglected due a very high demand on the market.

It may be assumed that the plants' production capacity is very often higher than the quality of the goods produced. As a rule there is a disproportion between the plant production capacity and capacities of the technical department which should support the production, particularly of the Product Development and Design Department.

However, it should also be said, that it is very difficult and expensive to provide technical support services of such quality and capacity as to be able to prepare and control a wide and changing assortment of products produced in small series.

On the other hand, construction of specialised plants, furnished with equipment adapted for a production of a specific type of machinery in large quantities requires also a large market beside the high investments in the necessary technical manpower and specific plant equipment. Such specialized plants must be able to develop and improve their products continually. They must confront strong competition by the companies intending to take as big a slice as possible of the market "cake". Only very large production series are able to sustain the costs of market investigation, improvement of the existing and development of the new products.

The market for agricultural machinery and equipment judged by yearly sales holds a distinguished place on the list of world trade. The need for permanently increasing food production is setting two requirements:

- increase of the cultivable soil and
- increase of the yield per surface unit.

One of the important factors contributing to the fulfillment of these requirements is the application of continually improving agricultural machinery and equipment adapted to help achievement of the set goals in the optimal way. It must be kept in mind, however, that it is very risky to apply directly the solutions optimal for one region to other environments where the circumstances may be different. This means that it could not be expected that the agricultural machines adapted to conditions valid for a particular region (climate, crop type, tradition, pedological situation, etc.) would automatically be suitable for other regions where different conditions are prevalent. Following this idea it may be concluded, that direct copying or acquisition of licence rights for certain types of agricultural machines, without prior careful testing of their applicability for local conditions, presents a business risk that may involve loss of time and money.

The deeper one becomes involved with problems of agricultural machinery production the sooner it becomes clear that the main problems do not lie only in the type, size and equipping of the plant where the farm machinery is to be produced. Adequate financial resources may ensure the purchase of the necessary equipment in a relatively short time. But it is of paramount importance that the equipment stay "activated", that it produce the necessary goods under required time scheduling and in planned quantities at an acceptable price.

If we go back now to the use of existing Multipurpose Plants for the production of agricultural machinery, particularly in the developing countries, we are of the opinion, that employment of the erection of Multipurpose Plants, under certain circumstances represents the most effective way for the setting up of organized production of simpler types of

machines. It is necessary to mention here, that the production of more complicated machines like tractors, combine harvesters, etc. is not possible without highly specialized plants and the necessary supporting industry (hydraulics, motors, foundries, forgerise, etc.). Consequently, we would not go further into problems of such production, because it is beyond the scope of this paper. Since in most developing countries there already exists a number of smaller or larger Multipurpose Machinery Plants the question to be answered is: How such recourses could be employed to cover the needs of the agricultural production? Or, is it effective to erect new Multipurpose Plants intended for the production of many various types of agricultural machines.

Essentially, both questions, assuming secured demand, may be reduced to a more essential one concerning the availability of the engineering personnel i.e. adequate competent technical Institution able to:

- make the selection of future products
- explain why those products are to be produced
- to provide the production with the needed technical information
- to establish authoritatively characteristics, quality and applicability of the machine produced.

Dealing with the issues mentioned requires an organized team of experts whose employment demands extensive financial resources. In the field of agricultural machinery, before the production of new products may start, extensive work to define each product should be undertaken by a number of groups consisting of specialized experts such as:

- agronomists, specialists for mechanization, with the task of determining for particular plants the optimal machinery application,
- agronomists, specialists for pedology, to determine

the method of soil cultivation that should not endanger its pedological structure,

- biologists for selection or breeding of such plants as will give the best crops when cultivated with appropriate machines,
- mechanical engineers responsible for providing technical documentation necessary for the production of farm machines fulfilling established requirements. In cooperation with the above listed agricultural specialists they provide necessary information by designing, copying or the aquisition of the licence rights or foreign know-how.

It should be born in mind that we have listed only the most important questions and steps which could be taken int consideration before starting up production of a new product. The list of problems to be faced is far from complete.

The question may be raised, does the copying of a machine of proven efficiency under local conditions or aquirement of the necessary technical documantation through licence rights, i.e. foreign know-how imply the shortening of the period necessary to prepare the production of a new product? Generally the answer is "yes". It should be noted however, that even in such cases the Production Works must receive from "someone" information about:

- what is to be produced and
- according to what technical documentation the selected machinery is to be produced.

In the first case, when the locally accepted and tested product is copied, it is necessary to provide the technical design documentation required for the production.

In the second case, when the licence rights, i.e. know-how is aquired, some competent local Institution should provide the Production Works with "domestic" technical documentation, arranged in accordance with local requirements but

after adequate previous testing and the conclusion that the farm machinery in question optimally meets the local condition and needs.

It is essential to keep in mind that in both cases it is of the utmost importance to keep improving existing new products and developing and designing better and more productive ones. Copying and obtaining the licensee rights can only be the first step towards effective commencement of production intended for certain areas of the national economy, in this case agriculture. Continual copying or dependence on licence rights cannot secure longterm development of national economy, but its combination with the establishment of its own Development and Design capacities is generally regarded as the fastest way to accomplish desired goals, i.e. organized production of the necessary farm machinery and equipment.

The mechanism of a new production organization which has been described is an expensive one and requires teams of experts competent in various fields. It involves long-term continual activities bringing in positive end results. Yet, this is work requiring extensive financial resources, many man-hours of hard work, skilled manpower consisting of experts enjoying their job and receiving adequate remuneration for their labour.

We shall go back now to the main topic of this paper and raise the following questions:

How many production plants can bear the cost of such specialized departments and institutions needed for the successful and efficient production of such machinery as is demanded by agriculture?

Furthermore, what is to be done with existing plants having sufficient production capacities but where it is not possible to organize and maintain Product Development and Designing Departments?

The answer to the question: "should the existing Multi-purpose Plants be directed towards the predominant production of farm machinery, or should new plants intended for the production of agricultural machinery be erected?" depends on the

quantity and assortment of the products that can be absorbed by the existing market during the next 5 - 10 year period. A certain preaction is necessary since it is difficult to assume the existence or easy erection of the plant able to produce a very wide assortment of articles. Methods of production between particular farm machinery types differ very widely. The production of plows, disk-harrows and cultivators, for example, differs very much, from the standpoint of applied production methods, from the production technology of various sowing machines, not to mention driven and selfpropelled machines.

Judged from the technical standpoint, the concentration of the production has its positive and negative aspects. Some of the advantages are listed below:

- Concentration of the technical personnel resulting in improved efficiency.
- Better possibility for the standardization and unification of parts, materials, technological and production methods, etc.
- Better utilization of the plant equipment.
- Lower investment costs needed for the erection of a large plant in comparison with those necessary for the construction of several smaller plants of equivalent total production capacity.

Opposed to this are the disadvantages of concentrated production which are:

- Large plants require high investments costs which are not justified if small Multipurpose Plants are in existence.
- Large plants are often not flexible so that reorientation toward some other type of production requires much more effort than in the case of some smaller plant.
- Large plants are more complex and consequently more difficult to organize properly. They also require more managerial effort. This is particularly important in developing countries, since there is not much experience with management of large complex plants.

The best solution should be, in each particular case determined by in-depth analysis of all the relevant technical, economical, political and other factors. For the topic of this paper remains as an important fact, that it is necessary to provide capable and experienced engineering personnel organized within a specialized institution able to determine the production program involving the most efficient agricultural machinery types to serve for optimal mechanization of the farming, independent of the decision as to which type of production plant is to be employed for the manufacture of them, i.e. one large production plant or several Multipurpose Plants or a combination of both.

Since that represents a very complex task requiring, as mentioned, many experts from various branches and considerable financial resources, it is necessary to find the best way of accomplishing such concentration of resources.

The importance of food provision makes this issue so significant, that the solution should be sought at a national level. It must be considered if viable to provide centralized preparation of technical data, in this case provision of design drawings and other technical information necessary to organize the production of agricultural machines. This can be done by organizing an Institution on national level, financed through the state budget and controlled through some convenient body. The results of the work of such an Institution should be accessible to all production plants, regardless of whether they be state owned or private.

Such solutions are naturally not applicable in cases where the plants are owned by foreign capital and under technical control of the mother-company. But in all other cases, when the licence rights or know-how is secured, or other arrangements made, it should be required that all technical documentation pass through the domestic technical Institution to be validated, and as "domestic" forwarded to the plant's Production Works.

What is meant by "provision of the design and technical

documentation"? This is how we term the preparations of the drawings and other documents containing all the necessary data and requirements concerning new products intended for the market, whose production is to be organized.

The procedure of design of agricultural machinery involves many activities and actions, the most important being listed below:

1. Determination of the activities that should be mechanized.
2. Determination of the local conditions under which the machine is going to be employed.
3. Selection of the optimal type of plant for which the mechanized activity is planned.
4. Determination of the basic parameters of the machine, its output performances and the characteristics which are expected.
5. Execution of drawings - design documentation in order that the prototype may be built.
6. Laboratory and field testing of the prototype for determination of its applicability for the planned purpose. The control and comparison of working performances obtained with "as designed" values.
7. The preparation of final design and technical documentation based on the testing results.
8. The forwarding of certain number of drawing copies for use by the Production Departments.
9. Organization of the Modification Group in order to execute accepted modifications by introducing changes in respective drawings and other documents.
10. Implementation of the Institution's own standardization of materials, production methods etc. in accordance with the relevant National and International standards and regulations.

It is difficult to imagine how all the activities described under 1. to 10. might be executed centrally^{on} one site. Specialized Institutions for biology, pedology, genetics, etc. participate in establishing the requirements for the mechanization of certain operations within farming procedures involving cereals and vegetables, citrus etc. Once the needs and requirements have been determined in this way, they serve in due course as a basis for the selection of machine specifications. It is beyond the scope of this paper to suggest where such a specialized Institution might be located. Our intent is rather to emphasize the need for the establishment of certain basic data before the task of designing the farm machine is undertaken.

The "Institution" mentioned, let it be called "Development and Design Centre" or for short "Centre", requires for the activities preceding the design of the machine, a small department employing a few experts, agronomists and mechanical engineers. Those experts should be experienced and capable in order to define the desired performances and basic technical specifications of the required machine on the basis of furnished data and requirements. The resulting document prepared by experts from various fields serves further on as a basis for all activities whose aim is the manufacture of the necessary machine. This document facilitates:

- The organization of activities for the acquisition of the machine from domestic or foreign manufacturers.
- Provision of the necessary engineering and technology data through licence agreements in order to organize production locally.
- Selection of existing farm machines, proven under local conditions, in order to provide the technical documentation by copying.
- Development and design of the original machines.

When analysing the problems and possibilities of Production Plants it is highly necessary to emphasize, that it makes

no sense even to contemplate the organization of production, particularly in Multipurpose Agricultural Machinery Plants, if the development and design departments, i.e. Development and Design Centres are not provided.

The issue of organizational jurisdiction and location of such a Centre shall depend on many factors, as for instance:

- The technical and financial resources of the Production Plant.
- The number of experts employed by the Plant, their experience and their usefulness in product development and design activities.
- The possibility of engaging domestic experts for various fields relevant to work on development and design problems.
- Possibilities of engaging foreign experts.

In principle, the best solution is to organize a Product Development and Design Department within the production plant, whenever the possibility of this exists. Such a Department should be able to provide the technical data necessary for the organization of the production, to control and update the products already manufactured, and to develop new machines.

When there is no possibility of organizing such departments within production plants, the development and design activities must be organized at national level. The production plant retains or organizes a rudimentary office which represents the nucleus of a future body and serves in the meantime as the link between the production plant and the National Centre. Under favourable political condition it is possible to organize such specialized Centres to cover the needs of several neighbouring countries. In this way more efficient use of scarce engineering personnel is provided and the financial burden of the Budgets of member-states is smaller. In this way, experts from member-countries may as well through the activities of The centre increase their knowledge and experience working under more favourable conditions.

The major problem encountered in development and design activities is the lack of experienced engineering personnel. Most developing countries, particularly the smaller ones, have at their disposal very few of the necessary experts. How and in what way can this problem be resolved? There are several ways, such as:

- The employment of foreign experts under adequate remuneration.
- Bilateral agreements with friendly developed countries.
- Help of experts through United Nations Development Program, i.e. other specialized United Nations Agencies.

Through favourable agreements it is possible to secure along with the experts a part of the equipment necessary for product development and design activities.

It should be noted here that the engagement of foreign experts presents only a temporary solution. Their support is generally restricted to a particular job during which the domestic engineers are supposed to gain enough experience to be able after a certain period to continue their work in the product development and design field, alone or with occasional temporary help.

For the better illustration of these ideas two examples will be presented further on. One concerns the activities of the "Institute for the Mechanization of Agriculture - Zemun", Yugoslavia, the other, the operation of "Engineering and Industrial Design Development Centre" Cairo, Egypt.

The Institute for the Mechanization of Agriculture was founded in the year 1946 as a centralized institution for the development of agricultural machinery in Yugoslavia. Most of the factories producing agricultural machines and implements at that time had no means of securing their own product development and design departments since the production had just been in its initial phase. At the Institute was assembled the

maximum available number of domestic engineers from relevant fields supported by foreign experts assigned for shorter or longer periods to work at the Institute.

The task of the Institute was to select for manufacture a number of the most needed and best suited agricultural machines; to choose those machines on the basis of the results of its own investigations conducted on various, predominantly foreign types of machines; to execute designs of the selected machines, build their prototypes and carry out their testing. In cases where the prototypes passed the testing, the Institute had to provide the complete technical documentation necessary for the production and forward it to the factory interested in organizing the manufacture of that particular type of machine. At that time institute was financed by the State Budget.

As time passed, the factories were becoming more resourceful and they started to build their own product development and design departments. Many experts employed by the Institute, working on machines of specific type, switched over to work for factories producing those types of machines. The need for a central, all-purpose Institution was diminishing and consequently there was a gradual transformation of the Institute's activities. Today, the budget subsidizes only projects of national interests. The state finances also certain projects supported financially by interested companies but only up to 50% of the total project cost. The main income of the Institute is however earned through direct business arrangements with interested manufacturers of farm implements and agricultural co-operatives. In the field of development and design the Institute cooperates with Agricultural Machinery Plants offering the necessary support to the factory's corresponding departments. In some cases the Institute develops independently certain machines and equipment surrendering the technical documentation and production rights for a fee to the interested parties. Additionally, the Institute is engaged in the mechanization of particular operations and production processes in agriculture, carries out testing and the certifying of tractors, motors and farm implements and

plans efficient machinery for the agricultural cooperatives and privately owned farms.

The civil engineering and architectural Department operates independently within the Institute and executes projects of agricultural facilities - cattle and poultry farms, cereal drying plants, refrigeration plants, fodder processing factories, dairies, etc. - on the basis of direct business arrangements with the interested parties.

The example presented is of interest because it shows clearly the phases of the maturing of the farm machinery development and design activities in one of the developing countries:

- a. The concentration of farm machinery experts at one Institution since single factories are not able to provide efficiently their own product development and design departments.
- b. The growth of the production capacities in the country resulting in the gradual overtaking of the activities and experts from the central Institution by Production Plants.
- c. Transformation of the central Institution into an independent specialized consulting Centre.

The second example concerns the "Engineering and Industrial Design Development Centre" in Cairo. On behalf of the Egyptian Government UNIDO Established in cooperation with the Egyptian Ministry of Industry, the Project bearing the above stated name.

The functions of the Project were:

- To provide the Government with a central body to handle all aspects of planning, development and prototype construction for machinery and equipment as well as for a large variety of mass-produced products for industry and commerce.
- To serve as an experienced and practical organization

for the most efficient screening of new or industrial development projects for both private and nationalized industries.

- To provide an applied training programme in engineering and industrial designing for graduate engineers through real work exercises.

c The Centre was managed by UNIDO. UNIDO provided during a period of 10 years the services of foreign experts, specialized equipment and a number of fellowships to Egyptian experts. The Egyptian Government contributed land, buildings, materials, suppliers, equipment, operating expenses and salaries for local staff.

The services of the Centre were free of charge in the beginning. Later, factories were obliged to cover only part of the expenses for services extended to them.

During the period of 10 years the number of UNIDO experts varied between 5 and 12 according to current needs. Some of the experts were sent to work in factories, for shorter or longer periods, to carry out particular jobs.

The Centre employed permanently around 150 workers and among them 60 technicians. A certain number of the technicians employed by the factories were active temporarily at the centre and their number ranged from 5 to 20.

After 10 years of UNIDO support the Centre stopped being a UN Project and continued its operation as a local institution within the Ministry of Industry. The Centre cooperates today with numerous Egyptian companies and acquires most of its income through arrangements.

The biggest success of the Centre is effective implementation of the idea, that there can be no prosperity and advancement of production without adequate product development and design support. Consequently, the number of product development and design departments within local production plants increased as logically expected, followed by the permanent flow of people and information between the Centre and the factories.

The considerations set out in this paper are of a general nature and only basic principles are mentioned here. Each individual case, whether it is that of a single one or that of a group of Production Plants, should be treated separately and analyzed in detail, in order to find the optimal solution for its particular and own situation. It should not be forgotten that good preparatory activities based upon solid and reliable data have to represent the basis for making decision about the use of financial funds. But in any case the conclusions concerning Product Development and Design Activities are clear and they are as follows:

- It is impossible to have an efficient production without well organized, capable and competent product development and design services.
- The best solution is to organize product development and design activities within Production Plants.
- Those services must employ more experts of greater experience if the plant produces various products, in this case various agricultural machines.
- When it is not possible to organize product development and design services within manufacturing plants, they have to be formed at national level by assembling the maximum number of domestic experts with or without experience.
- If the local development and design experience is lacking, it is necessary to secure the support and participation of experienced foreign experts by assigning them to particular jobs and to the training of domestic personnel.
- The main task of the Centre should be to provide Manufacturing Companies, producing agricultural machines with all the necessary data and documents needed to organize the production of the necessary machines.
- The services of the National Centre should be free

of cost in the beginning, symbolically priced later and accessible to all existing and prospective production plants.

- The final goal of the National Centre should be the preparation of the production plants to organize and successfully manage their own product development and design departments.
- The acquisition of licences, the copying of the existing machinery types or procurement of foreign know-how may serve only as a means of gaining experience more quickly, of shortening the production organization period and of initiating higher technical level of production.

