OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

09184

Distr.
LIMITED

UNIDO/EX.65
18 December 1978

ENGLISH

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

IRSI INSTITUTION BUILDING.

THE ROLE OF PILOT PLANTS.

INDUSTRIAL RESEARCH INSTITUTE STRATEGY*.

Papers prepared for the
Joint UNDP/UNIDO Evaluation Study
of Industrial Research and Service Institutes

by

Richard H. Westergaard**

* The views and opinions expressed in these papers are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. These documents have been reproduced without formal editing.

** Chief Engineer, Central Institute for Industrial Research (SI), Oslo, Norway.

id.78-8702

IRSI INSTITUTION BUILDING

		Page
1.	What is institution building	1
2.	Planning phase	2
3.	Implementation	3
4.	Continuation phase	5
5.	Conclusion	6

THE ROLE OF PILOT PLANTS

1.	A pilot plant is a small scale simulated factory process	7
2.	Process development in pilot plants is costly and difficult	8
3.	Pilot plants for market research are often useless	9
4.	Testing various raw materials may be a useful function	9
5.	Pilot plants as a means of convincing buyers	10
6.	Pilot plants belong in industry	10
7.	General purpose pilot plants have been given up	11
8.	Special purpose pilot plants, is a different concept	11
9.	The question of pilot plants in research institutes	12
10.	Useless pilot plants are common	12
11.	Conclusions	13

INDUSTRIAL RESEARCH INSTITUTE STRATEGY

1.	Institute building and development	15
2.	The situation and ambition of each country is important	16
3.	How to start an IRSI	17
4.	An IRSI must have a target	18
5.	Appropriate-adapted technology	20
6.	Transfer of technology is basic	21
7.	Research projects should have maximum national impact	22
8.	Determining industrial needs	23
9.	IRSI role in national plans	23
10.	Scientific research is better than pipe-fitting	24
11.	IRSI combined with teaching	25
12.	Commercialization of research results	25
13.	Conclusion	26

IRSI INSTITUTION BUILDING

1. WHAT IS INSTITUTION BUILDING

UNIDO's role as institution builder can vary from full responsibility for building the institution as such, and down to pure technical or financial assistance related to *one* of the institutes' activities. *Whatever UNIDO's part is, it should be clearly defined, and understood by everybody.* Before any project is approved, the critical conditions for success must be identified and evaluated, so that realistic plans are secured. The four most critical factors are usually:

- There must be a target industry and/or government agency which needs (or will need) the services offered. (It is an illusion to assume that the institute can create the target.)

- It must be possible to attract, train and keep competent staff, local or expatriate, with sufficient academic and practical knowledge.

- The finances must be secured.

- The plans must be realistic, allowing sufficient time for organic growth. (Shock establishment is not possible.)

Institution building falls in three main phases: Planning - Establishment and Continuation.

For each of the phases certain essential elements or objectives can be defined. It is important to have a plan for how the responsibility is to be shared between UNIDO and counterparts. It is also important to have project routines which reflect the successful or unsuccessful implementation and secure that proper corrective action is taken whenever an objective is not met as planned. Below are listed some of the more important elements for each of the three main project phases.

2. PLANNING PHASE

2.1 Define and describe the target industry and/or government agency planned to use the services of the institute and ascertain the present and future demand for such services

2.2 Define the institute's role among similar and related institutions present and planned for the future

2.3 Prepare a 15 years development plan for the institute, for instance defining three phases

2.4 Define the substantive activities of the institute (in this document called: activity modules, such as various departments, labs, services, etc.) and when each of them shall be operational

It is very important when planning an activity module to make very clear on which academical level it is planned to operate. The following levels can be used (or adapted):

level A
- scientific research on international level
- applied " " " "
- consultancy services to developed industry

level B
- trouble-shooting
- simple product and process R&D
- advise mainly to intermediate industry

level C
- routine testing and calibration, and similar
- advise to cottage - and small industry

A module or an institution may in principle cover A, B and C, but one level should be defined as dominant. Activities on level C may start at the institute and after some years be taken over by others. Level A may be modest during the first years, and then gradually become dominant. In the long run it is difficult to cover all three levels. One main level with some of one of the others is good.

2.5 Plan the institute buildings. If setting up buildings takes place in phases, prepare detailed plans for the buildings needed in phase I, and more summaric plans for phase II and III

2.6 Develop and find acceptance for a plan for financing the institute

2.7 Decide how to govern the institute: degree of autonomy, board, etc.

2.8 Assess the plans, if necessary revise them until they are considered realistic in every respect

---

The planning phase may require anything from one to three years, but sometimes - if carried out inefficiently - it takes much longer. A relatively short planning period is preferable. UNIDO assistance from headquarter and/or by consultants will practically always be needed if UNIDO is planned to play a major part. Several experts are needed: one for overall planning and in addition short term consultants for each activity module (at least the more important and difficulty ones).

3. IMPLEMENTATION

Implementation goes step by step, and the plan shall define the sequence and timing.

3.1 Premises. Premises may exist or need to be rebuilt, or new buildings shall be set up. But for each step or phase premises must be secured and all plans adjusted if premises are not available as planned

3.2 Activity modules (service units). All activities should be defined as belonging to an "activity module". Establishing a module involves the following elements, which must all be carefully planned and implemented:

- premises with utilities like airconditioning, gas, electricity, detailed layout showing each workbench, larger equipment and furniture, cabinets, hoods, etc.

- equipment: major, minor and expandable, stores, spareparts, tools, safety equipment, also office equipment and handbooks and journals

- staff to be hired, and trained to use the equipment, calibrate and maintain it

- work routines including forms to be used

- marketing: find work for the module, establish good relationship with the buyers of the services offered

3.3 Establish management

- premises for managers and managerial functions

- equipment like typewriters, copying facilities, filing cabinets, etc., furniture and similar

- recruit staff

- develop routines, forms, manuals, etc., which include the following:

  Organization: lines of communication, distribution of authority, job definition, staff meetings, etc.

  Personnel functions: contracts, salary policy, staff benefits like vacations, pension, insurance and similar; continuous education; travelling expense rules; staff association; canteens, etc.

  Office routines: accounting and auditing, filing and typing instruction, handling of in-and outgoing mail, purchase routines, billing procedures, organization of secretarial functions, etc.

  Project routines: contracts for secrete, confidential and open projects, project approval forms, reporting, termination, etc.

- train staff to use all routines properly

- train staff to be good managers: sale, execution of research, internal personnel relationship, etc.

- establish public relation functions

To establish a good management is often neglected and a frequent short coming. Great emphasize should be given to this aspect of institution building, which is at least as difficult as handling the science and technology aspects.

The establishment phase consists of establishing an administrative nucleus with adequate management and a number of established and working activity modules, defined for phase I of the institute building. The time required varies with circumstances, for instance with what the starting position is, how good the staff is, and how difficult the task is. It is much easier to establish various routine services - like simple materials testing - than research and consultation services catering to a developed industry. Phase I may take anything from 2 to 10, sometimes 15, years (if the country is less developed and the ambitions high).

4. CONTINUATION PHASE

An IRSI is never fully established. Constant changes and in most cases expansion are needed. Certain activities are abandoned or taken over by others, other activities are expanded or contracted, new activities are added, preparations for future needs are made. The transition from establishment phase to continuation phase is gradual. But it can as a rule be said that the first phase is completed when the institute administration and financing function well and a fair number of the activity modules are well established and functioning. In most cases UNIDO/UNDP assistance changes from having primary institution building responsibility to playing a role as consultant and giving technical assistance as needed. It is under the present system difficult to find a proper mode of operation in this phase. A proman may not be needed - nor longterm experts, fellowships and shortterm consultants and equipment are often wanted. Advance planning of this assistance more than a year or two ahead may be difficult.

5. CONCLUSION

It is possible to define the various elements (objectives) of institution building and to define the role to be played by UNIDO by using the general approach described, adapting the special conditions in each case. This element - or module approach can to advantage be used in all phases of a project: planning, implementation and evaluation.

All job descriptions and all equipment should be defined as belonging to a specific well defined activity module. Each expert, or small groups of experts, should be responsible for part or the whole of establishing an activity module (techno-economic department, information center, metallographic lab, metrology lab, chemical analysis unit, and so on). Equipment should always be part of such a module. It takes high expertise to make sure that all and everything needed for the module is taken care of. (Too often costly equipment is received, but is of no or little use because it lacks support equipment, qualified staff, spareparts and means of maintenance - or that there is no real need for it.)

This module (element, objective) approach helps to define the task of the experts so that it becomes something tangible. An expert can produce the plans for a module and implement them. To a much lesser extent can he transfer more general know-how. To give things a good start is his job. The success thereafter is mainly the counterpart's resposibility.

Many of the modules are more or less similar for a fair number of institutions, and UNIDO could develop a manual for each of the more common ones. The terminal reports from experts setting up such modules should always provide complete description of the module set up, and UNIDO will soon have very good background material for planning such units and experience can be accumulated. As it now is, each expert starts from scratch, except for his personal experience. With very good background material it will be much easier to succeed, and the expert will not need to be a superman which is often needed the way this was done in the past.

THE ROLE OF PILOT PLANTS

1. A PILOT PLANT IS A SMALL SCALE SIMULATED FACTORY PROCESS, BIGGER A LABORATORY SET UP OR A SO-CALLED BENCH SCALE OR BARREL SCALE BUT SMALLER THAN A PRODUCTION PLANT

Pilot plants became very popular just after the second world war. The slogan was: "Make your mistakes on a small scale and your profit on a large".

Most pilot plants are more or less continuous in their operation, but seldom are all steps in a process scaled down models of the contemplated factory. The more trivial process steps may be effected by batch operations, at some other plant or similar. Pilot plants can have one or more of the following main objectives:

a) Experiment with equipment and process conditions for the purpose of developing the process as such

b) Produce some of the contemplated product for the purpose of market research

c) Test out various raw materials with respect to processing conditions and quality obtainable

d) As a sales gimmick to convince buyers that the process is reliable

Pilot plants are from time to time necessary, and all the above mentioned objectives can be the justification. But there is today, in developed countries, a tendency to avoid pilot plants when possible. The reasons for this are discussed below and should give some guidelines for decisions for or against pilot plants.

2. PROCESS DEVELOPMENT IN PILOT PLANTS IS COSTLY AND DIFFICULT

2.1 Pilot plant operations are very expensive and time consuming, particularly with the very high wages in the developed countries. It is today possible to do most of the work on paper, except when hot, moving solids are involved. But to study this, very large pilot plants are needed.

2.2 It is often difficult to scale down the operations. The small size creates its own problems, and some of the phenomena associated with full scale operations don't lend themselves to be studied in a pilot plant. Corrosion and erosion may need hundreds or thousands of hours of operation to develop, and conditions in pilot plants are often not representative.

The same can be said about scale formation and accumulation of impurities in the process inventory. In many processes like extractive metallurgy, most of the difficult problems are associated with handling of solids, particularly at high temperature, causing such penomena as: bridging, plugging, sticking, dust migration, segregation according to particle size or gravity, erosion, heat transfer problems, and similar. Such problems often need very large pilot plants for their study and a small continuous production plant will often be preferred.

Other scale down problems relate to the fact that there is a different scale factor for linear measure, surface and volume. In a pilot plant the volumes are too small, by a factor of 1000 compared to the linear scale factor. This results in too short retention times, high surface heat loss, etc. To design a proper pilot plant is thus a job requiring people with first class knowledge of modelling, process theory and practical plant operation, and one must be very familiar with available types of equipment. An expert covers only his own field.

Pilot plants are in other words not an easy and particularly cost/effecti e way of solving process development problems, and is certainly not a job for the inexperienced.

3. PILOT PLANTS FOR MARKET RESEARCH ARE OFTEN USELESS

The usefulness for this purpose is often much less than one would think. If the product one wants to test is an input for other industry, and is not new and does not solve some essential problem, one will be met with the cold shoulder: "We cannot take the cost and risk of testing it in our plant". In most cases, they will not even try it in their laboratory unless you pay for it. They will not be willing to negotiate a contract before you can offer your product in commercial quantity. In developing countries one will often be met with direct animosity because local inputs so often mean trouble. Foreign owned factories are more interested in importing from their mother company. Other selfish interests are often involved. (Consumer goods, processed food and similar can to advantage be tested on a selected local market for acceptability. This usually requires much less investment in pilot plant facilities and is more often justified.)

4. TESTING VARIOUS RAW MATERIALS MAY BE A USEFUL FUNCTION

When a company has successfully developed a process and also in case of conventional processes, pilot plants are used for the purpose of testing out various raw materials with respect to the quality of the product they give and to determine the best process conditions. Such pilot plants are used in connection with pulp and paper, and extractive metallurgy. But this way of testing raw materials, etc., is costly. Pilot plants used in this way are often part of the research facilities of large transnational companies, and are very seldom successfully set up as part of a research institute.

Manufacturers of process equipment often have pilot plants where customers can have experiments done to see if the equipment is suitable for the process under development. This is very useful.

5. PILOT PLANT AS A MEANS OF CONVINCING BUYERS IS IN MOST CASES WASTE OF MONEY

If the enterprise which has developed a process is not itself engaged in production, for instance is a research institute, and finds that industry is not convinced by the laboratory results, calculations and drawings presented, it is sometimes said: "We must be able to demonstrate our process in a pilot plant". This thinking is more often met in developing countries than in developed, and is in general only justified if the process to be sold is a simple one to be sold to a great number of users, for instance a baking oven, a small kiln for the cottage industry and similar. In these cases it is misleading to call it pilot plant. It is a full scale demonstration prototype. Related to so-called appropriate (low level) technology such demonstrations are of course absolutely essential. But pilot plants in terms of scale models (more or less simplified) of more complicated *processes* is very seldom justified for the purpose of convincing reluctant buyers. If a customer cannot be attracted and involved at an early stage, the probability of success is by experience in developed - as well as less developed countries, very low, and pilot plants for this purpose are simply not justified.
(A different thing is to produce prototype models of a smaller, mechanical, electrical or other piece of equipment. When the word "pilot plant" is used one refers to *process* industries.)

6. PILOT PLANTS BELONG IN INDUSTRY, SELDOM IN RESEARCH INSTITUTES

Pilot plants are sometimes operated at research institutes, but normally at industrial plants. If there exists no target industry who can - or will - build and operate the pilot plant, this is a very strong indication that it will not be worth while to build one. One of many reasons is that to establish a "grass-root, research based industry" is a very high-risk-enterprise and a time-taking and resource-demanding one, which - as a rule, with only few exceptions - has no place in a less developed country. The research institute will not have the technical -

nor the economic skills needed. The country can develop much faster following other avenues.

In conclusion, process pilot plants belong in industry. They can be located sometimes in the institutes, but without a competent industrial counterpart, they are not justified.

7. GENERAL PURPOSE PILOT PLANTS HAVE BEEN GIVEN UP. ONLY AD HOC PILOT PLANTS ARE JUSTIFIED FOR PROCESS DEVELOPMENT

After the second world war the chemical engineering concept "Unit operation" was very popular. General purpose pilot plants were established. They should have equipment for each unit operation: dryer, grinder, sifter, evaporator, destillation apparatus, and so on, and in addition some pumps and similar, and a good stock of Quick-fit glass components. By combining the needed number of unit operations, connecting them with pumps and attaching some gauges and other instruments, any process, one believed, could be pilot planted with a minimum of ad hoc designed or purchased equipment. This thinking is completely outdated. For each unit operation there exists a great number of possibilities. And a well designed pilot plant can seldom use any of the equipment in stock. *The stock of equipment soon turned out to be a junk-yard. Pilot plants today are ad hoc pilot plants.* All equipment is ordered or designed very carefully for the specific task. As a matter of fact, the general purpose pilot plant concept was never a success, and with the degree of sophistication of today's process industry, only ad hoc pilot plants are still set up. After use, the equipment is normally sold or junked. The probability of being able to use it again is so small that it does not pay to demount and store the parts. Often they are left as they stand and parts taken from them when they can be used.

8. SPECIAL PURPOSE PILOT PLANTS, IS A DIFFERENT CONCEPT

A mono-purpose, mono-branch or similar institution will often have special pilot plants, for instance for tanning, food processing, textile processing, and similar. The purpose of these plants must be so chosen that the plants are used regularly. In that case, one can have a staff familiar with it and enough projects to pay for at least a substantial amounts of the operating cost. The purpose of such plants

can be: teaching and training, marginal research: studying process optimization, how to treat various raw materials, test out new raw materials, additives, chemicals etc. Such tasks can usually be well defined and justified. The equipment is conventional, and is to 95 % used to work on conventional, established processes and products. Innovation research usually plays a modest role. The work is of a routine nature needed by an established industry which must be large or have a very good potential. *If no such target industry exists, such laboratory plants have no purpose whatsoever.*

9. THE QUESTION OF PILOT PLANTS IN RESEARCH INSTITUTES IS CONTROVERSIAL

If the purpose is to convince (non existing?) customers, the answer if pilot plants are requested, should be: No! If the purpose is to establish grass-root research based industry in a little developed country, the answer is: No! If government wants industry where there is very little, the answer is: No!

Generally, pilot plants (this does not include demonstration prototypes or plant for educational purposes) are only justified in close cooperation between an institution (doing more or less research) and well established industry.

10. USELESS PILOT PLANTS ARE COMMON!

It is also true that UNIDO has promoted and assisted such mistakes. The fault is not necessarily UNIDO's - at least not alone. Let us consider why pilot plants are often requested.

- Some countries believe they can avoid being exploited by the rich countries by developing at least some of the technology they need themselves, and for that purpose pilot plants are said to be needed.

- They have certain resources they want to develop to improve the trade balance, like ores or other minerals, or biological resources.

- Existing research institutes are often believed to be too academic and are asked to do industry relevant research and then start to invent all kinds of products or processes using local inputs. To their disappointment, industry is very seldom interested in their inventions, and they believe demonstration in pilot plants can solve the problem.

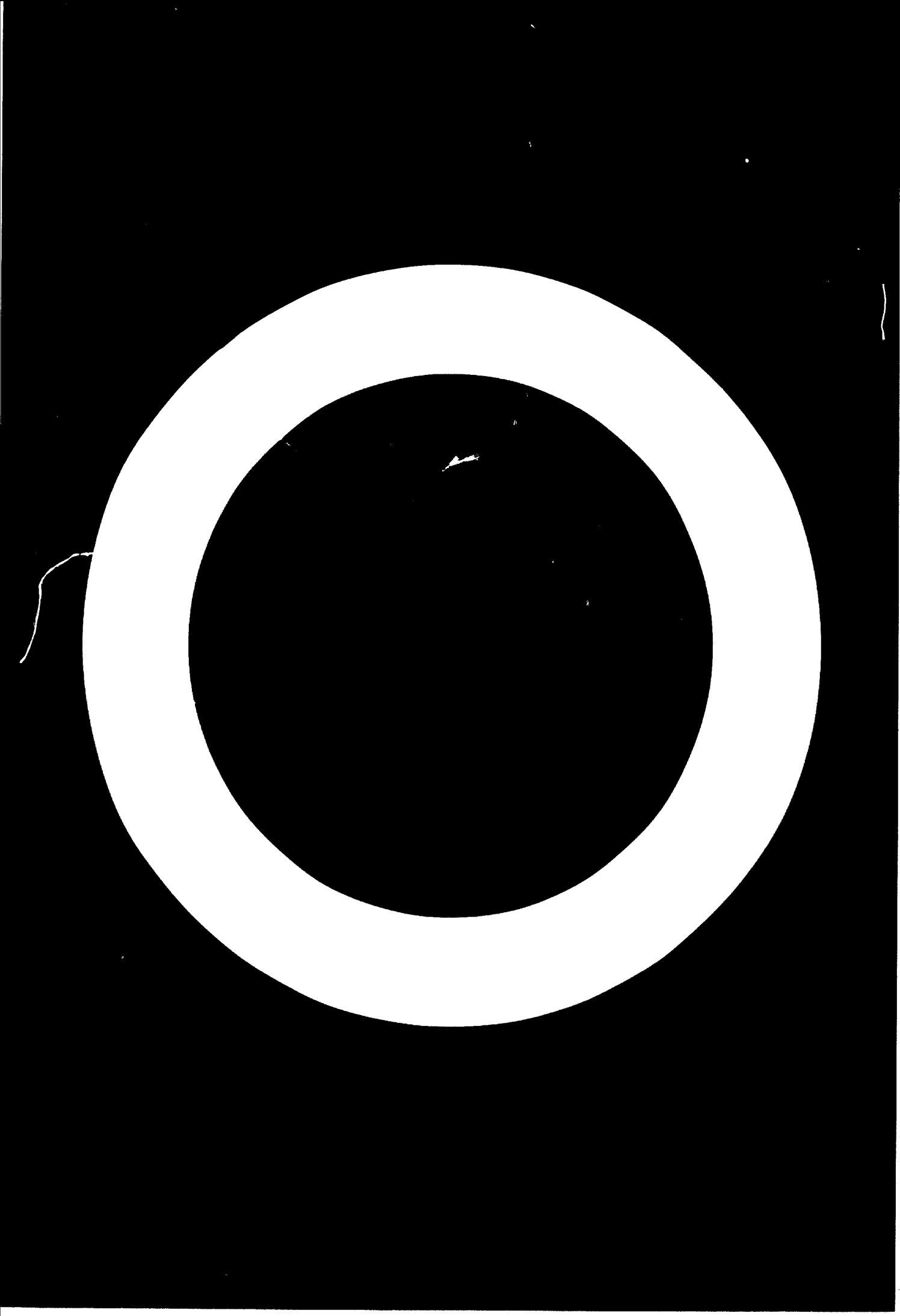
Arguments of this nature may sound very convincing to the politicians, and often are also accepted by UNDP/UNIDO. But the sad fact is that such ways to development are extremely slow and expensive. The failure rate is extremely high, and the industry which results from such efforts will most likely be inferior and inefficient. If it produces inferior inputs to other industries (for instance steel of inferior quality), it may also hurt large sectors of the industry.

Today's modern sector industry is so sophisticated that no nation can produce much of its own technology. Even in the most research intensive industries in the most advanced countries 98 % of the inputs are purchased from outside or consist of established technology already familiar to the organization.

The primary role of research is not, and never was, to create industry. Research is more like the salt and spice in the stew, not comparable to the meat and vegetables. The less developed a country is - the less it can benefit from industrial research in the sense of developing new technology. - Some people believe they need research in order to catch-up, but this is an illusion.

11. CONCLUSION

Request for UNDP/UNIDO assistance for setting up pilot plants should be looked at with great sceptisism and never be approved unless justified by very convincing statements produced by very competent consultants, knowing not only technology - but also economics, research policy and the special situation of the country in question. But most of the requests can easily be rejected by referring to, for instance, this document or other manuals which UNIDO will have to develop on research policy.



INDUSTRIAL RESEARCH INSTITUTE STRATEGY

1. INSTITUTE BUILDING AND DEVELOPMENT

It is extremely important that those responsible for Industrial Research Institution Building have a realistic understanding of what such institutions can and should do. This is indeed not a simple question because IRSI can do and do operate over a wide range of possibilities. Some are very narrowly specialized on certain industrial products or processes. We call them mono-branch institutes. Others have a broad science oriented general multidiscipline multipurpose approach. The role played also depends very much upon the state of industrial development in the country and on the expected future development. Can we despite of these great variations still generalize in a meaningful way? Well; I think so. There are certain principles which can be applied in most cases.

1.1 INSTITUTION BUILDING AND DEVELOPMENT IS A CONTINUOUS DYNAMIC PROCESS

An IRSI is not "built" like a building. It is much more meaningful to say that it is like a living organism. It has to be grown and during the whole of its life it will keep changing, shed off activities and take on others - hopefully, develop some very strong sectors while others are more routine in nature. The research planners must always have this in mind. *The IRSI is primarily there to help industry. But to be able to do so it must help itself. This is a very important aspect of the research strategy.* It must be "fed a proper diet" to develop and be successful. Some of the more important considerations are:

1.2 HIGH CLASS STAFF IS A MUST - it must be able to attract, keep, and develop high class staff members (government salary scale is often a serious obstacle). The work must be felt as useful and challenging by the staff.

1.3 A STEADY GROWTH RATE is essential. Sudden contractions or expansions are most harmful.

1.4 THE POLICY MUST BE FLEXIBLE and dynamic so that good opportunities can be taken advantage of: a gifted researcher can often build up an important activity not originally planned, and industry may offer interesting projects which can give the IRSI a boost if one is able to regroup people and skills to meet the needs. This is the basis of organic growth with survival of the fittest rather than bureaucratic planning.

1.5 UNSUCCESSFUL ACTIVITIES AND PEOPLE MUST BE PHASED OUT
If persons or activities prove to be a failure, this must be dealt with, without hesitation. Many good engineers fail as researchers and should be told to leave before they have ruined their career and harmed the IRSI. Many times one will need to phase out even larger activities and groups because they fail or because the situation has changed. It takes a very tough leadership to do this!

1.6 BUREAUCRATIC INSTITUTE CONTROL tends to be too inflexible, and institutes lacking *autonomy* can at the best develop into routine testing places, who do very little innovative and creative work.

2. THE SITUATION AND AMBITION OF EACH COUNTRY IS IMPORTANT

There are great differences between the various developing countries receiving assistance. Some countries in Asia are eagerly trying to follow Japan's example, and want an industry which can compete on the open world market. These countries sooner or later need all the laboratories, services and research facilities we have in the already rich and developed countries. The problem is only to find a proper strategy: decide upon sequence, pace and scope of the various institutions to be built. In this connection it is very important to work according to a long range plan with a horizon of 10 to 15 years. The more sophisticated capabilities in research, etc., take that long to be developed and must be started in a proper manner, early enough to meet the future demands. Too often, projects assisted by UNIDO are considered in a static manner and out of context, not taking into consideration that other institutions exist, new ones will be established - and that the institution being established in most cases will shed off many of the

earliest activities to new institutions, and itself either develop into a low-level routine institution - or into a more specialized and more and more sophisticated front research institute.

In all countries IRSIs must thus be seen as dynamic, changing institutions among others. In countries going for the same type of development as the developed countries, much of our experience is valid and assessment of plans is relatively easy.

In countries in a very early stage of development, often with a closed economy and ideals of developing a culture, production system and spectrum of products very much different from the experience of most people in UNIDO, the planning of institutions must follow other lines. Cambodia, China and some African countries fall in this category. But also they need laboratories, and they need research - perhaps even more than the first category. Much of the technology they need can not be purchased or established by setting up foreign designed plants and so on. In such countries the concepts of "appropriate technology" have much more relevance. Institutions in such countries need an IRSI concept rather different from the conventional ones copied from USA and similar countries.

3. HOW TO START AN IRSI

As already explained, a strategy is necessary. In a developed country a much used pattern is to operate for 3 to 5 years as a department of an existing institute or as a committee - or an "office", under the research council, often at a university. During this period a nucleus of staff is built up, plans developed, premises planned and set up, and work secured. Then the institute is finally established as an autonomous unit. Government subvention is great at first, and gradually decreased if the task of the institute is one where contract-income can be expected and is desirable. This is not always the case.

A newly established IRSI must never be told to start doing inhouse research for 5-10 years, and then go out and apply its skills. All staff must from the day they are hired have useful work to do, and staff must not be added before the newest staff has been absorbed.

Gradually, some of the activities become departments, and eventually some of them are shed off. The institute can still remain to be a multi-purpose, multidiscipline institute, but will probably reach a maximum of proliferation after 10-20 years, and then reduce the number of disciplines and concentrate on its most successful specialities. It must be decided relatively early if it should ultimately become an advanced research institute or a routine type of government laboratory. It can be both for a while, when starting up and when still expanding, but in the long run the two do not go well together.

4. AN IRSI MUST HAVE A TARGET

An IRSI can not be expected to play all of the many roles needed to establish new industry. There should exist an industrial counterpart in each R & D-project. The IRSI provides some critical building blocks, but industry must normally carry the bulk of the load, such as engineering, management, finance, etc.

4.1 IT IS WISHFUL THINKING TO EXPECT AN IRSI TO DELIVER TURN-KEY PROJECTS OR EVEN TO PRODUCE PRODUCT PROTOTYPES READY FOR PRODUCTION

To do so requires much too specialized know-how, and to achieve that, would use up much too much of the institute capacity so that it can not serve a sufficient number of clients.

4.2 WHY AN IRSI SHOULD NOT AIM TOO MUCH AT SMALL INDUSTRY

An IRSI should have equipment and skills of a more advanced type than its customers. To serve low-level small scale industry seems from this standpoint simple. It has often been advocated that IRSIs shall give extension services all the way down to cottage industry. This is very unrealistic for several reasons:

a) Academic researchers are too expensive to be used for such work. An instructor with a vocational background is a better choice.

b) The work is uninteresting and does not develop the capabilities of the staff.

c) The staff of an IRSI is orders of magnitude too small and the national impact of helping a few small enterprises will be absolutely

4.3 IRSI SHOULD MAINLY SERVE ADVANCED INDUSTRY

R & D is by its nature sophisticated and advanced, and only when it works for large and capable companies can results of importance to the national economy be achieved. (If one wants to help small and medium industry other means than IRSI should be chosen.)

4.4 IF THERE IS NO OR LITTLE ADVANCED INDUSTRY in the country, an IRSI should mainly do testing, analyzing, feasibility studies and inhouse research, rather than aiming at process and product development (R & D). *An IRSI does not create industry - it mainly helps existing industry.*

4.5 GRASS-ROOT research based industry created by IRSI is possible (some great successes can be referred to - from the most developed countries!). But *for underdeveloped countries this road to development is the slowest, riskiest and most costly which can be contemplated!* To the extent it is tried - it must be a minor activity reserved for really brilliant people with brilliant ideas!

4.6 GOVERNMENTAL DEPARTMENTS SHOULD USE THE IRSI WHICH THEY ESTABLISH to: prepare feasibility studies - for investigations of industrial opportunities, study of trends, etc.; investigation of natural resources; pollution problems; control of food or imported and locally made goods, etc. Such duties can secure a sound occupational basis, and as the society becomes more and more technology influenced governmental agencies need more and more scientifically based inputs for decision-making. An example is computer models related to economics or to ecological problems. It may be said that some 50 % of all projects can to advantage come from the government. If not, there is something wrong with the IRSI or the government - or both!

4.7 THERE ARE BOTH LONG AND SHORT TERM OBJECTIVES

An IRSI may concentrate on the immediate needs of industry, and if there is sufficient of advanced industry to be served, the IRSI can develop satisfactorily by so doing. In underdeveloped countries there may not be much industry needing advanced services of an IRSI. But one may have reason to hope that within 10-15 years the market for advanced research will be there and be of great importance.

It takes time to develop advanced research milieus, and in order to be able to meet the future needs, one may have to start today. This may be called STRATEGIC research, while catering for immediate needs can be termed TACTIC research. The government must pay for strategic research and industry can be invited to serve on steering committees etc. Such projects can e.g. be study of certain technologies like laser technology, computer applications or computer building, solid state technology, explosive forming, new energy resources, bio-chemical conversion of waste, etc. It must be understood that the purpose is not primarily to produce some invention, but to develop know-how and skills believed to have a market in a 10 years time. Some new process or product may result but should not be the yardstick of success. *The important output of strategic research is skilled people and research facilities.*

For an IRSI to develop products and processes and put them in a show-case hoping someone will use it, is a waste of effort. Building pilot plants to sell such results is throwing good money into a losing business!

There is in most cases surprisingly little difference between successful IRSIs in developed and underdeveloped countries. The reason for this is simply that all countries have a modern sector and the IRSI is mainly serving this sector, while the less developed sector needs other types of assistance.

5. APPROPRIATE - ADAPTED TECHNOLOGY

Many nice and wellmeaning ideas about appropriate technology have been heard lately, and indeed there are many negative aspects related to introduction of advanced technology into an underdeveloped country: social and ecological problems are very frequent and important. An IRSI could of course become a specialist institution on such problems. But when it comes to the technology as such adaptation to local conditions is very seldom an important function of an IRSI. The reason is that each technology requires great, detailed know-how and to alter it becomes a major R & D project the outcome of which is more than uncertain. Further more new industry which adapts too much to the underdevelopment

situation, is likely sooner to become obsolete and does not bring the country much forward. Few developing countries are interested in "appropriate technology" when they are planning their modern industrial sector. The low-level technology sectors may be more interested in this. Nothing negative is here said about intermediate or appropriate technology. But most successful IRSIs serve the modern industrial sector. The technology they work with is essentially the same as in developed countries. Certain considerations related to climate, service ability, cheap labour etc. are important and may be dealt with by an IRSI, provided it has specialized on that type of problems. Even the idea of labour-intensive industry based on cheap labour has some very negative aspects. One does not want to remain a country with cheap labour. The aim is usually a higher standard of living and development of a home market serving the common people. But of course one should give some preference to labour-intensive - rather than capital-intensive types of industry. Not because labour is cheap but because it is plentiful while capital is a scarce resource. Industry based on cheap labour may be a means early in the development process - but not an aim.

6. TRANSFER OF TECHNOLOGY IS BASIC

Basically an IRSI applies existing technology - only to a small extent does it develop really new technology. It usually mainly plays an indirect role - rather than directly assisting in the process of transferring know how etc. One could think of such functions as being responsible for selection of suppliers, processes, products, look after fair prices and conditions, secure spare parts and service needed, train national counterparts and similar. IRSIs, except for mono-branch institutes, are unfortunately seldom qualified to do such work. There are so many branches of industry and too few related cases to warrant such specialization. IRSIs do not particularly well lend themselves to this type of work! International agencies, e.g. UNIDO, could develop this type of expertice better than national IRSIs.

7. RESEARCH PROJECTS SHOULD HAVE MAXIMUM NATIONAL IMPACT

If an IRSI helps a few small industries with small problems it has no appreciable economic impact on the country. If a project can help a large export industry to expand its export, it is an achievement which does count. The same may be said about assistance in establishing local production of major items previously imported.

Another useful strategy is to give priority to activities which *help a group of enterprises* e.g. upgrading product control or by solving problems common to many users e.g. solve corrosion problems, standardization and so on. *To help industry to help itself is much more useful than to do for them what they ought to de themselves.* Doing sophisticated testing and analysis is O.K., but to do much routine, simple testing, is no good for an IRSI - instead the institute should help industry to establish its own laboratories and capabilities or shed off this activity to a non-research institution.

As soon as an activity becomes too much of a routine, the IRSI should try to hand it over to someone else.

8. DETERMINING INDUSTRIAL NEEDS

Particularly in developing countries where the industry is protected from competition from abroad, and where there is a sellers market, the industry will seldom recognize its need for assistance from an IRSI, and is seldom motivated for research. When an IRSI is planned, UNIDO often sends a mission to the country and they ask government and industry about their research needs. If neither industry nor government know much about industrial research (and they seldom do!), they will most often be unable to give useful advice! The things an IRSI could do for them they do not recognize, and the things they say they want are often entirely unrealistic (like turn-key projects and production ready prototypes and the solution of waste problems and use of unsuitable mineral resources, or similar). UNIDO can better assess the needs by analyzing the industry and by assuming that the needs are more or less normal. In other words, set up research facilities proportionate to existing and planned industry.

8.1 AN IRSI SHOULD MAKE A GREAT EFFORT TO PROMOTE ITS SERVICES

They should visit industry, participate in and run conferences and courses, go to other countries to see what the IRSIs are doing there. As inhouse or government paid projects various surveys of industry can reveal its needs. One can study such things as: quality control, quality of the goods produced, productivity and other indicators of efficiency, market trends, maintenance problems, need for automation and control systems, scope for use of computers, means for substituting imported inputs by local ones, find out promising import substitutes.

An important means is to run an information service and analyze the request and help industry to understand and use the information.

Another means is to exchange staff on a temporary as well as a permanent basis.

Proper annual reports and other public relation efforts can also help in establishing closer contact. But the best way of selling research and find out about the needs of industry is by doing successful projects in close cooperation. *Only when the researchers become intimately involved with industry, they will discover the needs which they can satisfy.*

9. IRSI ROLE IN NATIONAL PLANS

As already mentioned, a government which fully or partly finances an IRSI should use it as a tool in its industrial policy. Only by using it can the government manage properly. One important goal is, as mentioned before, to use the IRSI to breed highly qualified people. A more directly useful target can be to upgrade certain industries or make better use of certain raw materials and similar. But there are some very serious pitfalls. The government must know what can be expected by an IRSI and they must know how much time and how much money are needed. Too often the IRSIs are asked to solve problems which they have very small chances of solving. Problems of this nature are often related to: use of agricultural and industrial waste materials, upgrading of inferior iron ore - or other mineral resources of low grade or available in insufficient quantity.

Sometimes governments think an IRSI can help to establish entirely new industry instead of importing established technology. With such unrealistic objectives the IRSI is deemed to be a failure. *It is very important that UNIDO assists governments in using the IRSI properly, and I am afraid we often have failed in this respect.*

One of the things an IRSI can do is to provide input for government decision-making. Much research today is not laboratory based - but field and desk work like market studies and economic and social studies.

10. SCIENTIFIC RESEARCH IS BETTER THAN PIPE-FITTING

In UNIDO scientific and academic research have become "dirty words". One wants to be applied. But if a country can afford to do some (industry oriented) scientific research, this can have a most valuable long-term developing effect - much more so than trying to invent products and processes, and having to run pilot plants to promote sale of the inventions. Such efforts seldom give results of national importance, and the pilot plant-pipefitter-type of researcher cannot be expected to develop into anything very useful. He will most likely become a bad pipe-fitter and forget his science. To do some more scientific research is often the only means of creating high level capabilities and such research is relatively speaking not very expensive - and it can prevent the brain drain. Pilot plant operations are expensive and often such pilot plant projects actually do great harm! They may create unrealistic expectations and thereby delay import of technology. Sometimes it results in establishment of inferior, unprofitable industry, producing inferior inputs to other industries.

Of course, going academic to any great extent is no good, and IRSI should mainly always work for existing industry and for government on important day-to-day problems. But some scientific research is definitely desirable.

11. IRSI COMBINED WITH TEACHING

All IRSIs should arrange seminars, give courses etc. Often they are combined with regular teaching. But this teaching must be on the same academic level as the institute. A sophisticated, ambitious IRSI should have students doing their doctor's degree, or work closely with universities and engineering faculties. Institutions mainly doing routine testing and analyzing, can be combined with a school for technicians. And an institution catering for the small scale industry, rural development, cottage industries, and similar, can train shop operators.

12. COMMERCIALIZATION OF RESEARCH RESULTS

Some IRSIs feel that finding users for their results is their major problem. But if that is so, it clearly indicates that the IRSI follows a wrong strategy. It is probably involved in developing processes and products which the industry is not interested in.

An IRSI should be a fertile ground for new ideas needing research to be developed. Inhouse projects to find out if an idea is promising is certainly needed. But as soon as one has good indications that the idea is good, an industrial partner must be found, even if his contribution is small. If nobody shows any interest, the idea is probably premature, uneconomic, too risky or too difficult to develop, etc. And only as an exception should the institute inhouse projects go much beyond pre-feasibility studies, preliminary design and laboratory confirmation of basic assumptions.

Even when it comes to electronics and similar should the institute not try to develop a prototype more or less ready for production. Most likely the prototype will have to be completely redesigned, and much time and efforts are wasted. Even the classical problem of transferring the IRSI results to a *willing industrial partner is an indication of wrong strategy. The prototype should be developed jointly with industry.*

12.1 INVENTIONS ARE SOMETIMES VALUABLE

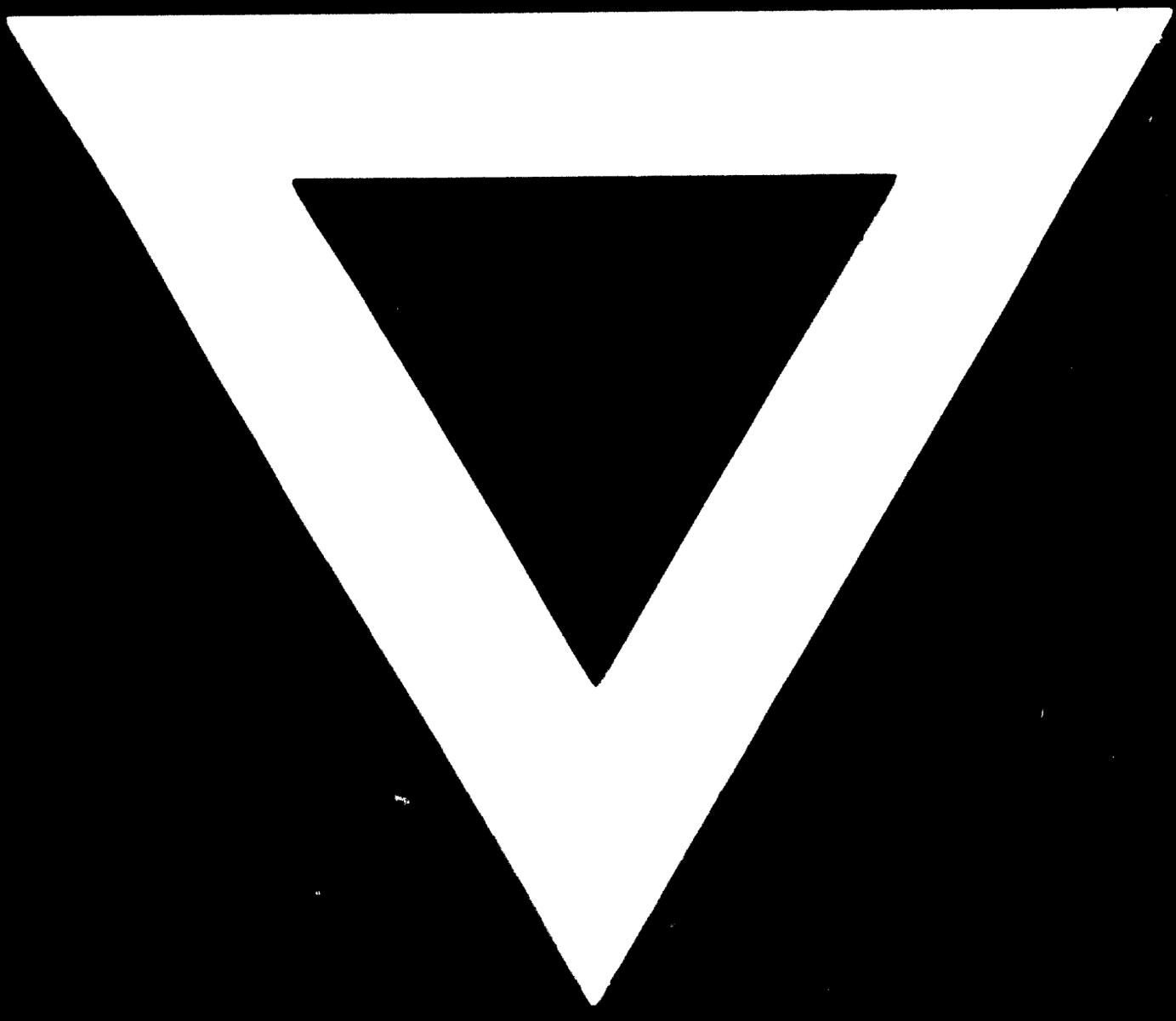
An IRSI sometimes develops products, processes, methods, etc. which have commercial value. In developed countries most IRSIs take out patents in their own name and try to sell the patent rights to make some extra revenue - or even in order to pay a royalty to the staff member inventors. This is fascinating and a useful incentive. But even in this case it is wrong to think that it is better business to perfect the idea too far by the institute. Also in this case, an industrial partner should be found as early as possible.

The policy of licensing inventions vary from country to country. Often, a government financed institute - which is non-profit in nature - is not allowed to do this kind of business. It also does have its pit-falls, as it can harm the trustful cooperation with industry. But in developed countries there are many examples of such commercialization. Sometimes a special firm, more or less independent of the IRSI, is formed to handle the business. *It is desirable to stimulate development of indigenous technology and become more independent of other countries.* The government can stimulate such development by subsidizing R & D projects. The government can give soft loans, tax privileges, etc. Often loans for R&D pilotplants, etc. need not be paid back, unless a profitable production results. Such means of stimulating commercialization of research results are used in many developed countries, like in Norway. It may have less potential in the less developed countries.

13. CONCLUSION

For an IRSI to be of much use to the nation, it must engage in close encounter with industry on all levels and on all stages. If there is no advanced industry, there will be only a marginally important market for research and the institute must concentrate on simpler services, possibly do scientific research of a long-term strategic nature. It must be realized that there are many other means of promoting industry than research and appropriate means must be used. IRSI is not a "cover all - cure all" means. The better the limitations of research institutes are understood - the more they can contribute by concentrating on things which are useful.

C-628



81.10.23