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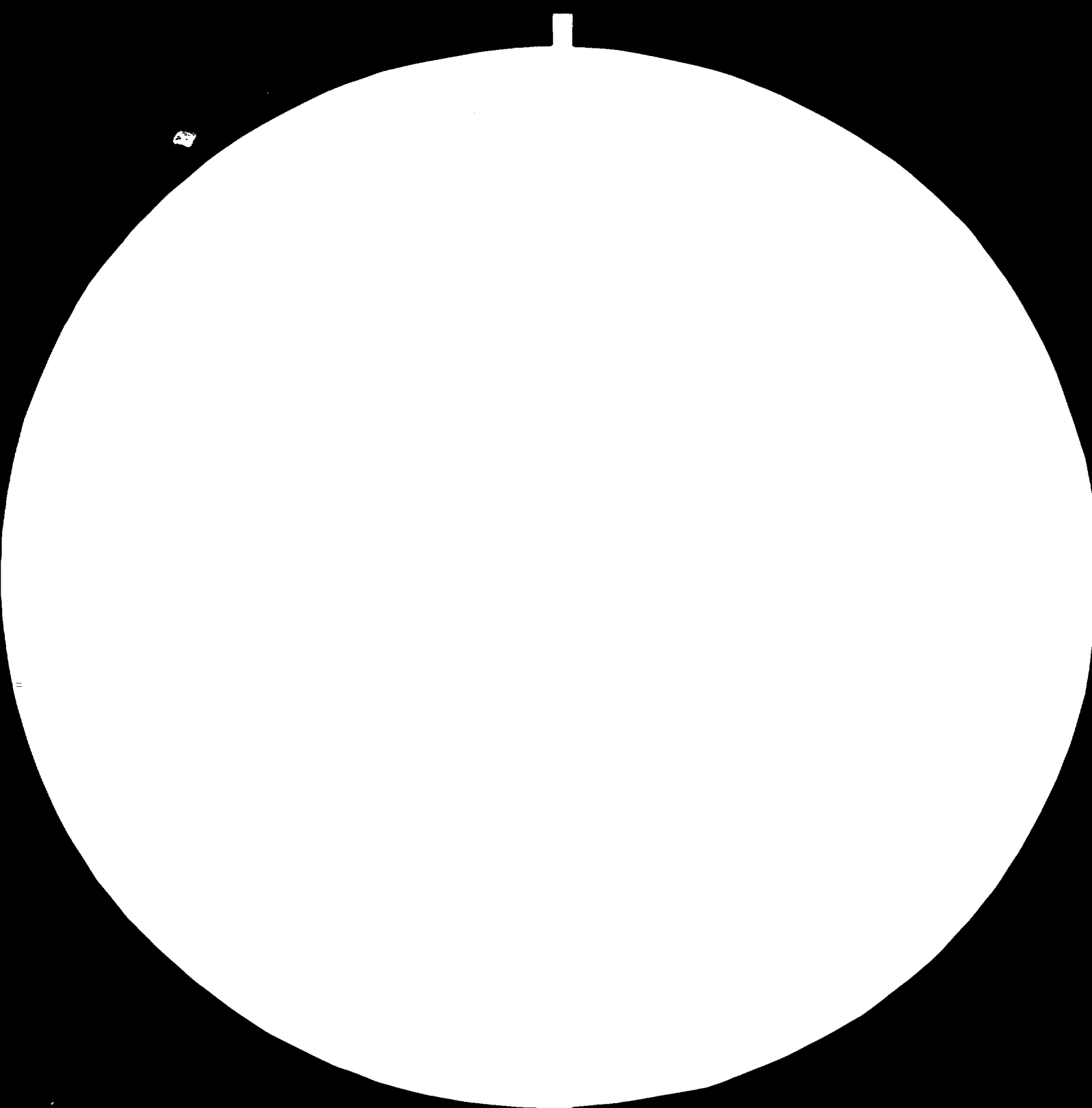

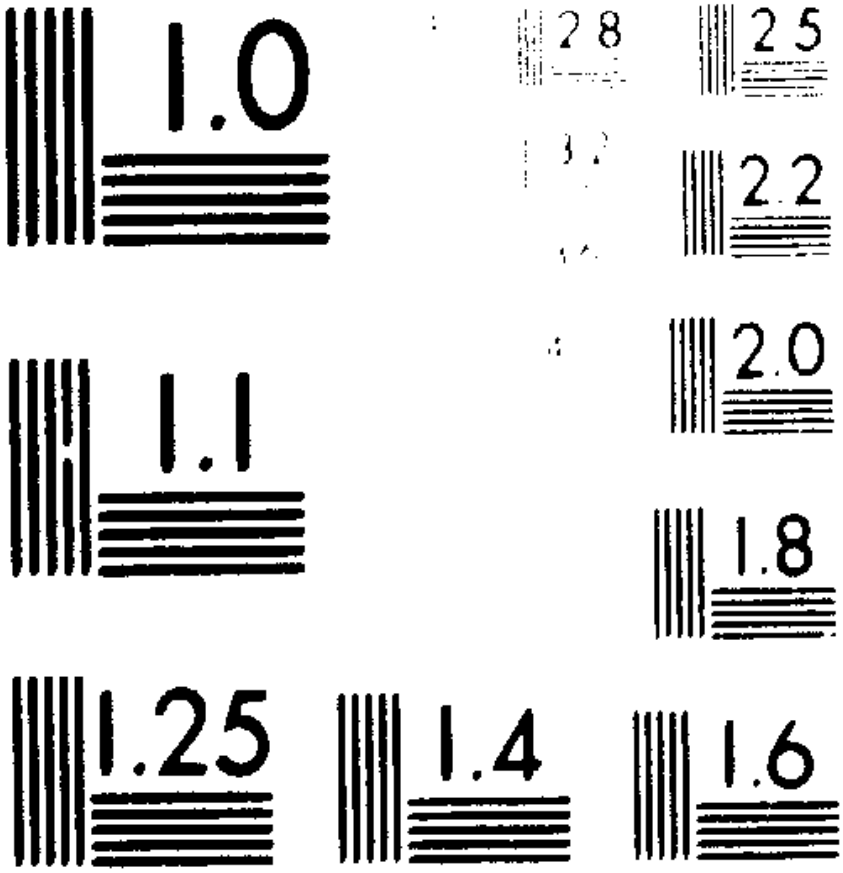

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# Industrialization of the Construction Sector in SAP Vojvodina

DP/Yug/76/001/11-05/B/32.1.2

## Project Findings and Recommendations

TERMINAL REPORT

prepared for the Government of Yugoslavia

by

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expert on building research
of the United Nations Industrial Development Organization
acting as Executive Agency for the United Nations
Development Programme

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## 1. SUMMARY

This report deals mainly with the actual and future position of the Institute for Civil Engineering IGV Subotica in the framework of the UNDP Project aimed at the industrialization of construction in SAP Vojvodina. Its starting points are partly the findings and recommendations contained in the previous Reports and partly the activities and findings of the author of the present Report. It conveys experience gained at research institutes abroad, characterizes the types of building research institutes and their development trends. The Report establishes a system of criteria for the assessment of activities of a building research institute and proposes to make use of these criteria when formulating IGV's future policy.

## 2. INTRODUCTION

### 2.1 The UNDP Project "Industrialization of the Construction Sector in SAP Vojvodina"

The primary function of the project No DP/YUG/76/ /001/B consists in providing direct support to the Construction Industry of Vojvodina by elaboration and introduction of a new modular construction building system.

Its secondary function consists in the introduction of industrialized methods in construction practice and strengthening of the ~~for~~ Civil Engineering Institute /IGV/ in Subotica

The development objectives have been formulated in the project document as follows:

" 1. Introduction of new construction design system based on a unique modular co-ordination with application of typified schemes of dwellings and unified prefabricated elements and components;

2. Extension of production capacities of the construction and building materials industries through modernization, specialization and concentration of existing production units, and setting up the new ones on the basis of industrialization of main construction works with application of modern techniques and technologies;

3. Further development of the construction research through strengthening of existing and establishment of new research teams, units and laboratories in order to introduce new building materials and components as well as modern techniques in construction practice."

Thus, the upgrading of the construction activities in Vojvodina comprises three closely linked and successive stages, which are indicated in order of importance and logic implementation.

The immediate objective of the project is the industrialization of the construction and building materials industries in Vojvodina region.

For this purpose it has been foreseen to implement the following sub-objectives:

" 1. Elaboration and introduction of a new prefabricated system, based on standard elements of dwellings which is to be applied first in the Vojvodina region. Preparation of a complete technical--technological and architectural study which will define a modular system of building construction using the components produced industrially in the factories."

" 2. Strengthening and improving of the Construction Industry Institute in Subotica with the aim to provide direct consultant services to the construction industry, particularly, in introducing industrialized methods, new materials and components in construction processes."

The mass production of prefabricated elements will create the conditions for the large scale application of industrialized methods in construction practice in the Vojvodina region.

On the basis of experience gained during the implementation of the project, it is foreseen to improve

the construction sectors in other Republics of Yugoslavia through the adaptation of prefabricated systems elaborated in the Vojvodina region to local conditions in other areas of Yugoslavia.

2.2 Work carried out by experts under the Project

Under the UNDP project "Industrialization of the Construction Sector in SAP Vojvodina" several experts have worked in Subotica, and other locations in Vojvodina. These experts and the duration of their assignments have been the following:

| | | | |
|---|---|---|---|
| - | J.W. Kapalski | - | five months |
| - | S. Wallin | - | three months |
| - | H. Stoecher | - | two months |
| - | J. Fuezy | - | three months |

These experts covered important aspects of the subject, including the following:

Kapalski: industrialization of construction and IGV's future role in this process.

Wallin : planning and design of industrialized building

Stoecher: structuring information flow

Fuezy : development of IGV's laboratories.

2.3 Assignment of the author of this Report

The author of this Report received from UNIDO/UNDP resp. from the Project Management an assignment to

serve as an expert for a duration of one month. Due to other commitments it was agreed to reduce the duration to two weeks. The job description for this assignment was issued, but the description of the expert's duties was not changed. Based on discussion with UNIDO Project-background Officer Mr. E.Csorba and National Project Director Mr. Rada Janjetov it was agreed to focus this expert's work on the work of IGV Subotica and its relation to the objective of industrialization of construction in SAP Vojvodina. Due to the extremely limited duration of the assignment the planning and implementation of the task, including the preparation of this Report had to be of a character very different from the previous assignments.

The factfinding period had to be reduced and much of the duration of the assignment had to be devoted on the one hand to oral discussions with the top officials of IGV and the National Project Director and on the other to the drafting of the Report.

Taking the findings and recommendations of the above experts as accepted, the author of the present Report restricted his activities to:

- discuss with the top officials of IGV Subotica their tasks, based on his experience as Director of a research institute deeply involved in the industrialization process;
- formulate in the Report some further recommendations not included in the previous Reports,
- define a general list of criteria for the assessment of building research institutes to assist the management of IGV Subotica to draw up future development plans and activities,

## 3. ACTIVITIES

The activities of this assignment have been the following:

- The study of papers and data on IGV Subotica and the UNDP Project received before the first mission to Subotica,
- two trips to Subotica to study the IGV and the facts about the construction industry in SAP Vojvodina,
- preparation of the draft of the Report,
- discussion of the draft Report in Subotica,
- revision and finalizing of the Report.

The last activity within this assignment will be realized after the processing of the final Report:

- one-day trip to Vienna UNIDO headquarters for de-briefing.

## 4. FINDINGS

### 4.1. The Institute for Civil Engineering /IGV/ Subotica

The Institute for Civil Engineering /in the following: IGV Subotica/ was formed some 17 years ago as a design enterprise. About 8 years ago it was transformed into a research institute and was equipped with laboratories five to six years ago. The Institute is still active as a design enterprise. It has a staff of 210 of which about 90 are engaged in design. Approximately 60 per cent of the Institute's income originates from design. The main fields of design are: industrial complexes /e.g. sugar factories/, silos and bunkers, melioration of soils, etc. Part of the research subjects are derived from problems encountered during the course of design /e.g. appropriate industrial floors in sugar factories, foundations etc./.

Another special feature of IGV Subotica is its close contact with teaching. Originally it had close links with a technical highschool with a curriculum of 2 1/2 years; graduates from this school obtain a qualification corresponding to the German "Ingenieur" or "Betriebsingenieur" to distinguish from "Diplomingenieur", a qualification given to technical university graduates.

In SAP Vojvodina /Novi Sad/ a Technical University has been founded and several highly qualified engineers of IGV Subotica took up teaching posts there.

The Vojvodina Technical University has a Faculty of Civil Engineering located in Subotica.

It is planned to strengthen further the contacts of IGV Subotica with the Civil Engineering Faculty of the Technical University. This aspiration will affect the organizational pattern of IGV, it being logical that the organisational schemes of the two Institutions should harmonize with each other. The University Faculty consists of three Sections:

- Structures and Buildings
- Hydraulics
- Roads and Railways.

The design activities of IGV Subotica are of practical nature. The Management would like to retain this lucrative activity, developing at the same time the research activities of the Institute.

On the other hand, the Technical University is rather theoretical-research-oriented and the task is to change this orientation of teachers-researchers slightly towards research and development subjects /referred to hereafter as R and D/ with more practical value.

IGV Subotica has been engaged in the past mainly in civil engineering, hydraulic engineering, and the design of factories. It has not been involved much in new housing, the reason being that traditional building techniques did not call for special engineering knowledge.

In the past few years the industrialization of construction - and first of all the industrialization of new housing - has become an objective of importance on the governmental level. This has been the reason why the Yugoslav Government launched the UNIDO/UNDP project. Under this project IGV Subotica

will have the important responsibilities to promote its activities in the field of the industrialization of construction.

As in many other countries the first phase of such activities consists in the elaboration of the structural and architectural solutions for industrialized buildings with an emphasis on the load-bearing structures including the catalogue of precast components and the organization of the production, transport and assembly of these components.

In a second phase the non-loadbearing parts of the buildings are developed, and at the same time efforts are made to improve the production, transport and assembly techniques.

In the next phase the whole industrialization process is tackled in its complexity and system theory is applied.

IGV too will have to face these aspects of industrialization.

4.2 Types of research institutes and development trends; lessons to be drawn

There are several abstract models /varieties/ of the so-called building research institutes. Four basic types can be identified:

1. "Pure" research institute" with the primary objective to create new knowledge through basic and applied research.

2. "Development institute" with the primary objective to assist the construction industry in offering new products and technologies. Some of these institutes actually are engaged in the design of buildings too /as is the case with IGV Subotica/.

3. "Quality control institute", its main field of activity being laboratory tests to assess the suitability for use of new building materials, components, procedures and systems.

4. "Information and documentation centre" concentrating on the regular gathering of data and information on the technical development of the construction industry and serving the industry by systematizing information and making it available for the industry.

The world's building research institutes are usually active in all four areas, putting the emphasis on one or two areas only. Some examples:

ad 1. There are few "pure" building research institutes. These are active mainly in mechanics, acoustics, building physics.

ad 2. Most East-European building research institutes fall into this category.

ad 3. E.g. EMPA in Switzerland, CSTB in France.

ad 4. E.g. Bouwcentrum in the Netherlands and CATED in France.
It has to be repeated that the above institutes are not active exclusively in one single area.

It is completely irrealistic to try to cover all four areas but it is usually desirable to maintain a certain level of activity in all of them, at the same time concentrating on one or two areas better than on others.

"Traditional" or "classic" building research concentrates on physical phenomena: mechanics, acoustics, physics of heat and moisture.

Some research in the field of chemistry has also been part of building research: the chemistry of cements, additives to concrete, corrosion and lately: the use of plastics.

In the last twenty years beside these classic branches of building research new fields of research have emerged.

- The study of economic, social and planning problems, both on a macro- and microeconomic level;

- the study of human /psychological, physiological, biological etc./ problems.

Not all building research institutes joined this trend; some, mainly testing laboratories /e.g. EMPA/ remained purely technical institutions. Most institutes, however, /including the relatively new ones/ carried out more and more research in these new areas. The management of IGV too will sooner or later face the problem to what extent it should enter this field.

4.3 System of criteria for the assessment of building research institutes' activities and its potential use

Below I want to draft a list of criteria that can be used as yardsticks to measure the achievements /actual or potential/ of research institutes.

Data characterizing the level of achievements or potentialities for the individual criteria can be summarized in different ways. The whole gamut of gimmicks for assessing complex systems can be put to use but it makes no sense to repeat here any of the methods that could be used for such purposes; if necessary I could quote ample bibliography on the subject. I will restrict myself to the establishment of the list of criteria with some explanations.

The criteria can be divided into some major groups:

A. Criteria for scientific /research/ achievements

B. Criteria for development /technological/ achievements

C. Criteria for the quantitative and qualitative level of equipment

D. Criteria for the quantitative and qualitative level of the institute's staff.

Each criterion has to be defined on a national and an international level. It should not be forgotten that in many cases defining a criterion on the international level leads to higher expectations than

the same criterion defined on the national level.

A. Criteria for scientific /research/ achievements

Quite obviously the task is to measure the unmeasurable. However, there are some indicators reflecting achievements indirectly.

1. Publications.

This covers several subgroups according to the type of publications. Different types of publications should be /but are not necessarily/ of different scientific value. So e.g.:

- publications abroad /especially in the case of small countries/ should be of higher value than domestic ones,

- publications in scientific journals /e.g. in those sponsored by Academies of Sciences/ should be of a higher scientific value than publications in popular journals,

- books should not necessarily be of a higher scientific value but cover a wider field than articles and therefore have a certain additional merit,

- publications co-authored by research officers of an institute with other /domestic or foreign; research or industrial/ authors show an active collaboration with others and as such should be assessed positively.

The majority of publications /articles, books/ can be put in one of three groups:

- progress reports, studies on existing problems, information about solutions used or proposed,

- reviews on foreign or international achievements with the objective to draw conclusions in the home country,

- publications containing new scientific knowledge.

Publications in the third group are of the highest scientific value; however, it would be erroneous to contest the value of other types of publications. In countries with more restricted economic resources it is advisable to devote independent scientific research to a relatively small part of the overall research potential and to concentrate the greater part of research activity on the reviewing of foreign developments and the adaptation of foreign achievements to domestic problems. Therefore certain areas of technical development are more often come reviewed by authors in developing than in developed countries.

The language barrier is a factor to be taken into account. In big countries with a language understood by a wide circle of readers /English, German, Russian, etc./ domestic publications become widely known. In small countries, or in countries with a language disseminated in a more restricted area, publications abroad, or in a foreign language have gained some importance and should be supported.

2. Citations.

It has often been stated that the value of publications can /tentatively/ be measured by the number of relevant citations.

Consequently, the research staff's publication activities should be supported by the management of the research institute and the number and kind of publications should be recorded regularly in order to get an /indirect/ picture of scientific research achievements.

3. External recognition of eminence

Scientific achievements are often reflected in the external recognition of eminence of research officers. Various forms can be distingished:

- joint publications of research institute officers with the researchers of other domestic or foreign organizations;

- invitation of research officers to serve as:

  -- speakers, session chairpersons or preparatory group members to international scientific functions,

  -- opponents of doctoral theses,

  -- tutors for postgradual studies of domestic or foreign students.

This criteria is one that could be included in group D too.

B. Criteria for development /technological/ achievements

1. Patents.

Patents have to contain something new and be aimed at achieving technical development. Patents issued not only in the country of origin but abroad too, could indicate a higher degree of novelty and potential for technical progress.

The number of patents applied for jointly by research officers of several institutes may show a high degree of cooperation and - in case of co-inventors employed by the enterprise that has to apply the patent - it may increase the probability of the practical use of the patent.

2. Recognition by the industry of the application of R and D results

Recognition can have different forms. The most tangible proof of industry's satisfaction is to let the institute share in some form the financial benefits /production volume, profit etc./ resulting from the application of R and D.

It is of a lower value /but still to be assessed positively/ if the industrial or construction enterprise makes certain public statements regarding the usefulness of the research institute's work. The form of these statements can be e.g.:

- reference to the role of the research institute when publicizing /e.g. on TV, radio, in newspapers etc./ the enterprise's own achievements;

- allusion to the name of the institute in the trade name of a new product;

- acknowledgement of the research institute's role in some other positive way. /e.g. by writing a letter of acknowledgement/.

It must be emphasized that "fishing for compliments" can be extremely harmful to good contacts of research and practice and an institute should never press hard for such gestures. Development processes usually require the cooperation of several organizations and it is very common that each participant /including the research institute/ overestimates its share in the final results. Though each participant is entitled to its share of acknowledgement this should never spoil the good climate of cooperation needed for further collaboration.

C. Criteria for the quantitative and qualitative level of equipment

Building research requires laboratory equipment costing more and more. Not even big institutes in big countries can afford to possess in every field the most sophisticated and most costly equipment. A good solution consists in grouping together research institutes of different branches; in this way duplications of equipment can be avoided and institutes specialized for particular fields of research can even have very costly equipment. Such "clusters" of research institutes exist in the Soviet Union /Akademgorod/, in Japan, in the USA and other countries.

A geographically isolated building research institute, not being member of any grouping, has to make a careful choice of the many possible types of equipment.

It is a natural tendency to try to possess some basic laboratories, e.g. in mechanics, acoustics, building physics. When such already exist it becomes an extremely delicate problem to decide in which direction to develop the institute further. A world-wide survey of unique equipment installed in building research institutes shows that even the duplication of these would involve unrealistically high capital outlays. I quote some examples of such equipment:

- large diameter boundary-layer /turbulent/ wind tunnels /existing e.g. at CEBTP/ Saint-Rémy-les Chévreuses/; CSTB /Champs-sur-Marne/ and even some larger types specialized for aerodynamical laboratories,

- sand boxes of large dimensions for geotechnical experiments /at the Moscow research institute for foundations NIIOSP/,

- 15-25 storey high towers for investigating water supply systems in tall buildings and experiments with dropping weights /e.g. at CEBTP and CSTP/,

- complex testing equipment for boilers, radiators and air conditioning equipment /e.g. at VUVA, Prague/;

- large-size testing machines in mechanics /e.g. at EMPA, Dübendorf, Switzerland; TSNIISK, Moscow/,

- large-size laboratories with controlled internal climate /e.g. at the National Bureau of Standards, USA/,

- fire testing equipment for large size components and structures, with synchronized loading equipment, /e.g. at ÉMI, Budapest, - INCERC, Bucharest/,

- large-size structures for the geotechnical testing of retaining walls and other soil structures, /e.g. at CEBTP, France/,

- laboratories for research on human comfort /e.g. at ÉTI, Budapest/,

- laboratories to test air shock waves /e.g. at VTT, Otaniemi, Finland/,

- seismic testing laboratories /several institutes in Japan, etc./,

- equipment to test hydraulic structures /at LNEC, Portugal, - VITUKI, Hungary, etc./.

Big institutes looking back on a long past /like e.g. BRE, Garston/ can have excellent and costly equipment in several fields. Institutes which are comparatively new could try to procure unique equipment in just one or two areas.

Costly equipment /laboratories/ should be installed in the particular fields where there are eminent experts available.

D. Criteria for the quantitative and qualitative level of the institute's staff

The Criteria in groups A and B /publications, citations, patents, etc./ can be used for the assessment of the quantitative and qualitative level of the institute's staff.

In this case it is not the number and type of publications, citations and patents that should be taken into account but the number of researchers that are authors of such achievements. There exist further criteria that characterize the quantitative and qualitative level of an institute's staff and in the following these will be described.

1. Qualification of research officers

In individual countries there exist different degrees of qualification. In several countries /USSR, Hungary/ the system includes the following degrees:

- Member of the Academy of Sciences,
- Doctor of Sciences,
- Candidate of Sciences,
- Graduate Engineer /based on a four to five years teaching curriculum/

In some countries /Poland, Yugoslavia/ the grade next higher to Graduate Engineer is magistership, with Professorship at the top in some other countries.

In Great Britain and the USA the titles of BSc, MSc, PhD are used.

Whichever the system prevailing in a country the number of highly qualified engineers /researchers/ indicate the standing of the institute and its scientific potential.

2. The size of research staff in certain areas

In some cases there may be only one eminent researcher in a given area. With his/her departure the eminence becomes lost. To be able to produce valuable results over a longer period the number of research staff in a given area must be bove a critical value. This ensures continuity, the productive and creative confrontation of ideas usually described in other words as a "scientific school", gathering younger, less experienced scientists around the older, more experienced. To contribute to the formation of such "schools" is an important task for the research institute's management.

3. Special qualifications of researchers

In countries with a language of a low degree of dissemination the language studies of researchers should be encouraged very much. The lack of the knowledge of languages hampers participation in international scientific life, which has its adverse consequences.

Researchers should also be encouraged to study certain special fields of science such as:

- modern mathematics,
- social and economic subjects.

4.4 International relations

IGV Subotica maintains well-founded bilateral co-operation with some 11 foreign research institutions and enterprises /see List attached in the Appendix/. However restricted these relations may seem as compared to those fostered by research institutes of larger size, they can still be regarded as a solid basis for gradual extension.

IGV Subotica is at present not member of any international research organisation nor is it involved in multilateral commission work in such organisations.

## 5. RECOMMENDATIONS

The recommendations made by the four previous experts are regarded as valid. In this Chapter some recommendations supplementing those made by the other experts are added:

1. The four experts have investigated IGV Subotica and the industrialization process from the architect's and the civil engineer's point of view. The work carried out by ATURBA has also been concentrated on the solution of the architectural and civil engineering problems of industrialization. I recommend to devote attention in the next period to the production engineering aspects. To implement this the next three points contain practical recommendations.

2. I propose to set up at IGV Subotica a unit /sector, section, group/ on mechanization and technology with the objective to study problems of and propose solutions for the mechanization of building processes, up-to-date industrialized technologies, the choice of machines and equipment to be used.

3. The architectural and structural problems can be solved by the use and further development of domestic systems and of the new system worked out by ATURBA. The industrialization of interior works /painting, flooring, installation of water supply, heating, electricity/ requires a thorough study of these processes /subsystems/. There exist

no experts with a universal knowledge covering all these processes; at least three categories have to be defined:

- painting, floors, doors, windows etc.
- water supply, drainage, heating,
- electric equipment.

Study tours and invitation of guest experts for these three groups are proposed.

4. The industrialization of processes defined under the preceding point cannot be achieved solely by proposing design solutions. Production facilities too have to be organized. In the past decades, it has become obvious in developed countries that industrialized construction cannot attain full efficiency without a well-developed so-called "industrial background". This means that the construction /and prefabrication/ industry alone cannot achieve the required degree of industrialization.

   New products, groups of products, subsystems have to be worked out and their production has to be organized by the competent enterprises. Capital outlays /investments/ are necessary, based on preliminary studies and project proposals.

5. The industrialization of construction under the UNDP project is actually concentrated on new housing. Experience proves that as soon as progress has been achieved in this area, the industrialization of other buildings in residential areas

/schools, nurseries, kindergarten, shops etc./ has to be solved. This usually takes the form of "system building" mentioned already in the Report by Dr. Fuezy. Industrialization should be achieved in other areas too: industrial and agricultural buildings, municipal engineering etc.

I recommend IGV Subotica to take gradually up R and D activities in these fields.

6. For the further development of IGV Subotica I recommend to bear in mind development trends in building research /Chapter 4.2. of this Report/ and the system of criteria of assessment proposed in Chapter 4.3 of this Report. These development trends and criteria - indirectly - contain manifold recommendations for IGV's development policy.

7. I particularly recommend to strengthen IGV's external relations, which would grant the institute a quick insight into the latest achievements abroad. In the next two points this recommendation is concretized for two main areas: participation in international organizations and bilateral relations.

8. I recommend IGV Subotica to join (formally as a full member and practically in an active way) CIB /International Council for Building Research, Studies and Documentation/, the international organisation offering extensive opportunities for research contacts through its network of

research commissions active in the fields of interest to IGV, e.g.:

- W19 Large Concrete Elements
- W23A Load Bearing Walls
- W51 Acoustics
- S41 Tall Buildings
- S66 Industrial Buildings

The CIB membership fee could be covered from IGV's budget or eventually - for one or two years - from the budget of the UNDP project.

Beside CIB some other participations could be proposed but in a well planned limited degree.

So e.g. participation in the new technical committee /TC/ of ISO /The International Organisation for Standardization/ on geotechnics could be investigated.

The author of this Report is prepared to advise the management of IGV on eventual other possibilities and IGV could take decisions depending on its financial means and the qualifications of its scientific officers.

9. It is not recommended to widen the list of bilateral partnerships drastically, however, a gradual extension of bilateral relations based on careful consideration is desirable.

10. I support the intention of IGV's top management to establish a new kind of relationship between the Institute and the Technical University. This could lead to experiences of interest for other countries too.

## 6. APPENDICES

### Collaboration with other Institutions

1/ Technische Universität - Berlin
Lehrstuhl für Entwerfen VI

2/ Institut für Siedlungswasserbau,
Wassergüte- und Abfallwirtschaft, 7 Stuttgart 80

3/ Lund Institute of Technology - Lund, Sweden

4/ PARTEK - Finland

5/ Council of Housing Planning and Construction
of Government, - Finland

6/ Keskus - SATO, - Finland/Helsinki

7/ VITUKI - Budapest

8/ ÉTI - Budapest

9/ MÉLYÉPTERV - Budapest

10/ POLTEGOR - Wroczlaw - Poland

11/ Process Engineering Company - PEC
- Switzerland - Männedorf