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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

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DESIGN OF A COMPUTER-BASED MANUFACTURING CONTROL AND INFORMATION SYSTEM FOR AN ENTERPRISE PRODUCING ELECTRIC MACHINERY

ID/HUN/74/010

HUNGARY

TERMINAL REPORT

Prepared for the Government of Hungary by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

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United Nations Development Programme

DESIGN OF A COMPUTER-BASED MANUFACTURING CONTROL AND INFORMATION SYSTEM FOR AN ENTERPRISE PRODUCING ELECTRIC MACHINERY

IS/HUN/74/010

HUNGARY

Project findings and recommendations

Prepared for the Government of Hungary
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of F. G. de Jong, Project Manager

United Nations Industrial Development Organization
Vienna, 1976

Explanatory notes

The following abbreviations are used in this report:

BOMP	Bill of material processor
CBMIS	Computer-based manufacturing and information system
CMEA	Council for Mutual Economic Assistance
CPU	Central processing unit
EDP	Electronic data processing
EVIG	Egyesült Villamosgépgyár (United electric machine works)
MIS	Management information system
PICS	Production and inventory control system

ABSTRACT

The project "Design of a Computer-Based Manufacturing Control and Information System for an Enterprise Producing Electric Machinery" (IS/HUN/74/010) was a continuation of an earlier project (IS/HUN/72/803).

The enterprise, EVIG, is a major manufacturer of electric motors and machinery. Systematic and efficient institutional systems support to industrial enterprises in Hungary is weak. EVIG as an enterprise has risen to this challenge and its systems group is now confidently applying the help-yourself-method.

With some minor additional efforts the following systems modules are ready for implementation:

Module B/R-I	Creation and maintenance of product structure and item master files
Module D/E	Standardized data entry
Module P/I	Physical inventory
Module print	Uniform management report print capabilities
Module conversion-data	Transfer from existing tape files to integrated new disc files

In addition the work on module B/R-II (technological master files creation and update) has progressed to the detail design phase.

Up-to-date systems design methodology has been implemented, including standards for:

Documentation
Programming
User manuals
Project management

In the report, it is suggested that EVIG assure improved hardware support, because access to current hardware is difficult and irregular for its programmers and alternative fall-back possibilities are required once the system starts running.

It is recommended that EVIG start now looking into the possibilities of locating an off-site computer to which it will have access by means of tele-processing techniques. Furthermore, that all aspects of its present terminal/data concentrator problems are defined and means are found to change the new

EVIC system with the help of this equipment from card input to user operated terminal input. EVIC should eventually assure access to an in-house computer compatible with modern integrated management and control software requirements.

The programming efforts devoted to the new systems should be strengthened. A programmer hiring campaign seems to be the only viable solution to this problem. EVIC would be well served by occasional outside consultants' support for a period of up to 4 weeks every quarter during at least the coming 12 months.

CONTENTS

INTRODUCTION

The enterprise, EVIG, is an autonomous conglomerate consisting presently of seven partly horizontally and partly vertically integrated manufacturing divisions. The total output of EVIG represents a major part of the entire national electrical machine industry branch (approximately 18%). The corporation resorts under the Ministry of Metallurgy and Machine Industry.

The project "Design of a Computer-Based Manufacturing Control and Information System for an Enterprise Producing Electric Machinery" (IS/HUN/74/010) was a continuation of an earlier project entitled: "Improvement of the Management System of an Enterprise Producing Electric Machinery" (IS/HUN/72/803)[1/].

The project was officially requested by the Government of Hungary on 4 October 1974. It became operational on 9 January 1975 and it ended on 19 April 1976. The Ministry of Metallurgy and Machine Industry was designated as the government co-operating agency and the United Nations Industrial Development Organization (UNIDO) as the executing agency. Initially, the UNDP contribution to the project was $77,500 for 6 expert posts (31 man-months). The budget was later increased to $104,300. Because of difficulties encountered in recruitment of experts the number of posts was reduced to 4 and the man-months thus made available were used for extension of remaining posts.

The objectives of the project were as follows:

(a) To improve the management control and the utilization of resources by designing and implementing a uniform computer-based manufacturing control system in the major manufacturing unit of the enterprise;

(b) To create during the design and implementation process an in-house competence to carry on the effort, upon completion of the project, in all other manufacturing units of the enterprise thus achieving a multiplier effect of the project.

1/ For the terminal report see UNIDO/TCD.404.

I. FINDINGS

A. Project activities

The design and implementation of integrated management systems goes far beyond the mere technology of systems and computers. Seen from the point of view of the management and users of the new system, it results in the acceptance of a new style of managing the enterprise and often major reorganization of authority and responsibility. This fact was recognized by the UNIDO team. It resulted in its activities being directed accordingly, as far as was possible in an advisory capacity.

It should further clearly be recognized that, both for purely technological reasons and because of the major impact it has on the management approach, the implementation of integrated management systems under ideal conditions requires a timespan of at least $2\frac{1}{2}$ to 3 years and often longer. Because of the modularity of such systems and the possibility this modularity offers for evolutionary implementation of parts as they become completed, this is not felt as a great drawback. That is, under ideal conditions, where management has already clearly defined its requirements, existing systems provide reasonable economic results and manpower resources are experienced and well trained.

The project activities were divided in six major phases:

Initiation
Analysis
General design
Detail design
Programming/testing
Implementation

Each of these phases were broken down in a large number of key activities. The phased development method was used to allow EVIG to develop and practise a sound systems project management approach. To that end all required manpower resources were organized in a project team and as far as possible relieved from any other responsibilities.

B. Project organization

The design and implementation of an integrated management information system is a very complex undertaking. Eventually it touches upon all administrative and control tasks in an enterprise. Its implementation introduces pervasive changes that will effect management as well as workers. A task of that magnitude in terms of required resources and impact on the future of an organization requires a major control effort on the part of management.

Assuming that a computer-based manufacturing and information system (CBMIS) is required, because current systems are overtaking management, the additional managerial task of guiding such a major effort presents management with a serious dilemma. Management can rarely find the time or has the required ready knowledge to exercise tight control over a major computer systems project. The alternative of delegating the entire responsibility to the systems designers is not acceptable. Experience clearly shows this to result in a machine-oriented rather than user-oriented system.

Careful organization of the project team and distribution of the responsibilities was therefore a major concern and received much attention. A number of key activities and responsibilities were highlighted which were expected to be potential stumbling blocks during the life of the project:

The involvement of top and user management in the decision making and control process

Early assignment of users to the project

Assignment of work places

Education of systems analysts

Selection and timely arrival of UNIDO experts

Selection of software and hardware

Programmer training and selection of outside programming support

User training

C. Management involvement

The day-to-day management of the project was in the hands of a project control group formed by the general manager of Factory No. 1, the chief production engineer and the head of the organization department. This set-up was created in an attempt to force line management to take the responsibilities for approval or disapproval of systems. The concept was new to EVIG. Systems work was defined as a specialists' function belonging entirely in the

organization department. The result of this belief had been isolation of systems personnel from line activities and less than desirable acceptance and credibility of its work.

A reverse trend took place during the life of the project, which is believed wholly attributable to the line managers' involvement in the project. Rather than the organization department pressing for implementation of its systems, the line managers started to apply increased pressure to accelerate the tempo. No greater assurance for success in computer systems work can be hoped for. This trend has to be considered one of the major successes of the project. The factory managers cannot be sufficiently complemented for their dedication and quick grasp of the importance of the work that was being done.

D. Assignment of user personnel

As a general rule, the involvement of user personnel in the design and implementation of computer systems is a conditio sine qua non. EVIG represented additional powerful reasons to emphasize this involvement even more than normally needed. The practical industrial work experience among the systems personnel was minimal and, because of this and other reasons, the user acceptance of and involvement in existing systems was minor.

The concept of the project was to eventually reach a point where the running of the systems, including data bank maintenance, would be transferred to the user departments. This was not seen as an additional task, but as a vastly simplified alternative to present tasks. To achieve this transfer successfully, an early participation of high calibre user personnel was required. It is believed that the management control group understood this need sufficiently. The realization, however, was slow. This was caused on the one hand by the lack of manpower and on the other hand by the novelty of the approach.

When the transfer did start to take place, promising results were achieved. The factory assigned two full-time members to the team. Engineering and technological departments initially assigned one each on a temporary basis and eventually drew the departments' managers in as well. Their knowledgeable practical contribution complimenting the systems team's theoretical systems design knowledge formed the basis for the project reaching specific bench marks.

Only in the major area of inventory control did the project fail to obtain full time user assistance. There is no doubt that this severely affected the progress of the inventory control module.

E. Assignment of work places

EVIG, like many industries, struggles with a severe shortage of office space. When, initially, a total of 10 to 15 EVIG employees were assigned to the team, lack of office and desk space reduced their effectiveness considerably. This was eventually solved in part when the new computer building was completed. EVIG's management should, however, recognize that even their present systems department offices are seriously overpopulated. This is now affecting the department's efficiency. If management's plans to hire additional, much needed, programmers are realized, the space problem could become one of major proportions.

The demand for experienced systems analysts and programmers on the Hungarian labour market is greater than the offer. It seems that the ability to hire and keep the best people could in part depend on the work environment created for them.

F. Education of systems analysts

The education of systems analysts, other than by means of practical guided work, was, in essence, not part of the project. It was proposed that this would take place in the months of October, November and December 1974, during the period between the projects IS/HUN/72/803 and IS/HUN/74/010. The fact that it did not take place during that period made it necessary to find an alternative solution.

It was clear that the EVIG participating systems analysts required some basic training during the project. It turned out, after much investigation, that these requirements for training did not coincide with the capacity at existing systems training institutes. The solution was finally found in a co-operative effort between the Budapest Technical University and the UNIDO team.

A complete course of approximately 230 lecture hours was organized and presented by the UNIDO team members and guest lecturers invited by the Technical University. This effort, unforeseen as it was, turned into a major extra activity for the UNIDO team. For the course outline see annex I. It would have been desirable if the entire contents of the systems design course could have been recorded and afterwards presented in written form. However, it proved to be impossible to record all lectures for the record and future use because the task of the UNIDO team, after all, was systems implementation and the course itself presented already an undue strain. Upon completion of the course the participants (15 in total) were asked to deliver an examination paper based on tasks related to the project's practical work. Upon presentation of these papers in May 1976 the Technical University will present the participants with an official certificate of satisfactory participation.

C. Selection of software/hardware

EVIG is in business of providing the Hungarian economy with electric motors and equipment. This seemingly obvious statement is made to support the UNIDO team's view, that these activities exclude involvement on EVIG's part in major software design efforts. The design of software is the terrain of specialists such as computer manufacturers and software houses.

Once this concept is accepted the die is cast for the adaptation of existing application software packages around which an integrated management system should be built. Normally the task that remains is to select from existing software packages those best suited for adaptation to the specific environment and once that is done, select the hardware configuration best suited to support the system. However, even when the initial project IS/HUN/72/803 commenced in 1974, EVIG was already committed to a hardware configuration of the type EMG 840, of indigenous manufacture. This proved to be a serious problem the ramifications of which were felt throughout the entire life time of the project and are expected to have an influence on EVIG's systems design activities for many years to come.

For a clear understanding it is needed to appreciate that the project title, "To Design a Computer-Based Manufacturing and Information System",

defined rather precisely the technology to be transferred to EVIG. The key to so called CBMIS is modular design of the system and data base orientation. To satisfy these conditions two courses of action can be taken:

(a) The selection and use of proven application packages;

(b) The design of tailor-made software.

The latter is an undertaking of immense proportions even for giants in the world computer market. For EVIG it could not have provided the objectives of the project within a decade.

The required packages, e.g. data base structure, production control, finance etc., do not exist for the EMG 840 configuration. It is not to be expected that the manufacturers can ever economically justify to undertake the design and testing of that kind of software. It was then clear that only one of the following possibilities remained:

(a) Abandon the original objectives of the project to transfer the latest systems technology and create an integrated data base oriented CBMIS. Instead, continue the further development of EVIG's tape file oriented operational systems in isolation from each other;

(b) Investigate the availability of software packages suitable for running on computer configurations other than EVIG's, but to which EVIG would still have long-term access.

The first alternative was rejected after much consideration and deliberation with managers of EVIG and government officials. The purpose of this UNIDO project was, like others, the transfer of up-to-date technology. And still, sooner or later, but certainly within the next 5-10 years, EVIG would have to undertake the design of integrated systems because of the inherent operational limitations of its current systems approach. The remaining alternative involved the UNIDO team and some of the counterparts in an unforeseen research task of major proportions. That was, to evaluate available software packages and determine to which degree EVIG could obtain and rely upon outside hardware support, compatible with the selected software. Practically every institute and organization in Budapest and Hungary with major modern hardware configurations was approached. The results of these investigations accompanied by the UNIDO team's recommendations were presented to EVIG's management in a report (see annex II). The report left no doubt about the fact that only a compromise solution could be found. A compromise considering cost, software/programming support and hardware available.

The institute finally selected to undertake the supply of software packages, programming adaptation support and machine hours was SZÜV. It had access to a late generation IBM/370 configuration, the accompanying data base management and operational application packages as well as well trained and experienced programming support. In fact, work contacts between the institute SZÜV and the UNIDO team were established and detailed systems design documentation was developed on the basis of available hardware and software when SZÜV withdrew its offer to EVIG.

The Ministry of Metallurgy and Machine Industry mediated in establishing contractual arrangements between another institute, KG-ISZSZI, and EVIG. The institute has access to a medium range third generation computer of the type RIAD-30 (CMEA produced). It has been involved in the adaptation of IBM's data base management package BOMP (bill of material processor) to the RIAD-30 and is currently working on the adaptation of IBM's PICS (production and inventory control system) package.

With minor changes in the design documentation the team was able to re-direct its efforts to suit the new situation. It is at this moment and for the foreseeable future the only way that EVIG can implement the system, while at the same time being independent of western hardware and its associated convertible currency problems.

H. Programmer training, programming assistance and hiring of programmers

High caliber programming know-how and experience with high level languages is a must if one hopes to implement systems of the complexity designed by this project. EVIG, although it had access to a number of in-house programmers with varying degrees of training, generally lacked experience. Experience can only be gained by actually doing progressively more complicated programming work over a period of years. Programmers with such experience do not seem to be available on the Hungarian labour market. This was amply demonstrated during the project's efforts in establishing software support contacts described in the previous section of this report. The problem of hiring programmers and of further training of the available ones has been a constant subject of discussions with the EVIG managers. It was mentioned in all progress reports and in the final reports of all experts who were on this project.

EVIG did assign two newly hired programmers to the project and transferred a further two from other current work to the team. All are promising talents, but inexperienced. The entire problem of all aspects of programming support still deserves careful management consideration. It is feared that underestimating the ramifications could form serious immediate and future hindrances in the orderly and successful implementation of systems. Although a large amount of programming assistance should be obtained from the software supply house (in this case KG-ISZSZI) in the form of adaptation of software packages to EVIG's unique needs, there still remains sufficient additional programming to be done to justify an in-house group of at least 10 experienced programmers. These programmers should be assigned to the EVIG/UNIDO system.

EVIG should embark on a serious hiring programme. Subcontracting is difficult and impractical, because the programmers need constant access to the machine configuration on which the system will be run (KG-ISZSZI/R-30) for testing and compiling purposes. It has been the experience of this team that subcontracting programming work is also very expensive. It is common amongst Hungarian programming organizations to maintain ownership of the programs written under subcontract. This is not a workable arrangement in a dynamic industrial environment. During the life of the system, changes and additions would have to be made on a regular basis. EVIG would thus, for as long as the system exists, have to have contractual arrangements with the original programming organization. Aside from the cost which would thus be mounting, the reaction time to change demands from users would certainly become larger than EVIG could live with.

I. The EVIG manufacturing control and management system

In this report the EVIG manufacturing control and management system is described only in general terms. The detailed description is contained in the systems documentation covering many hundreds of pages. They form the actual product supplied by the project to the EVIG enterprise. The computer's only task in the system is being the instrument through which the system can be profitably used by management in its daily control and decision making responsibilities.

In earlier sections of this report reference was made to the use of application packages. EVIG is not unique as a manufacturing enterprise. It is a classic example of discrete manufacturing with all universally encountered problems of product mix, planning, scheduling and investment optimization. The use of application packages in which problem solving experience of more than a decade has been incorporated was realistically the only sound approach to the systems development effort. The major problem was to determine which set of packages would be best suited for EVIG's use, and to convince the management of EVIG that any selection of application packages excluded the use of its own computer for the major task of running the system.

The key characteristics of a modern management control and information system are that the system is:

(a) Integrated. To assure that an activity logged by the system carries through all aspects of the chain of events in an industrial enterprise upon only its one original trigger;

(b) Modular. To allow simplicity and uniformity of design and to follow a priority implementation schedule. Parts of the system are implemented and used before the entire system is completed. The use and effectiveness of these parts are increasing as additional modules are added to the chain;

(c) Data base oriented. To assure singular recording of base data avoiding duplications and their associated built-in error possibilities. Allowing company-wide access to this centrally stored base data bank avoiding transmission delays and thus shortening the decision making cycle.

Preceding the final selection of software packages was the architectural design of a system best serving EVIG. This document entitled "General Systems Architecture for the EVIG Enterprise" became the management approved concept paper for all design activities following. It is attached as annex III. It defined the need of a total of 13 systems modules, some of which, possibly later, to be divided into submodules.

Of these 13 modules some are concerned solely with the creation of the data base, some with the need to serve the system itself (input/output/update) and the others with the actual activities of running and controlling the enterprise. Thus it became clear that software packages could be and should be used for the data base management modules and the operational modules representing that part of the system which is truly universal. Approval was sought and found to adapt the IBM packages BOMP for the data base system and PICS for the operational modules. The other modules (input/output/conversion) were designed tailor-made by the project team.

Manager information system (MIS) development procedures

At this stage, having made the application software selection, a formal development procedure was laid down. This procedure being a (simplified) approach to simultaneous multiapplication development. The approach is a proven, successful one, applied universally in industry in medium and large EDP development projects. Annex IV represents a copy of these procedures.

General systems documentation

In accordance with the documentation standards[2/] each module has a pertaining documentation file containing, when complete, the following sections:

General design
Detail design
Programming
Implementation

From this complete documentation a users' manual is created allowing the user to maintain established standards in operating and maintaining the system.

General design documentation[3/] for the following modules was completed, or was reaching completion at the end of the project:

Data base creation modules:

Basic records-I (B/R-I)
Basic records-II (B/R-II)[4/]

Systems service modules:

Common data entry

Output module:

Common print

First operational module:

Physical inventory control

A further module dealing with the conversion of existing data to the new data base had at the end of the project reached the programming phase. General documentation for this module exists only in the Hungarian language and is available at EVIG.

2/ For documentation standards see technical report DP/ID/SER.A/56.

3/ For the narrative of the general design documentation see technical report DP/ID/SER.A/56.

4/ For design specification see technical report DP/ID/SER.A/26.

J. Counterpart personnel

One of the major objectives of the project was defined to be:

> "To create during the design and implementation process an in-house competence to carry on the effort, upon completion of the project, in all other manufacturing units of the enterprise. Thus achieving a multiplier effect of the project."

This objective pre-supposed the involvement of as large a number of EVIG employees as possible. There is no question about EVIG's determination to bring this about. Prior to the arrival of the experts EVIG had already assigned a group of six systems analysts and three translator/analysts to form the permanent Hungarian team members. In addition to that a full-time secretary and a "protocol officer" were assigned to handle the administrative matters. Eventually two user representatives and four programmers were added on a permanent basis and countless others from engineering, technological, manufacturing, accounting and material departments became involved for periods of up to a month at a time.

In addition to this involvement of specialists the concept of having the project controlled and managed by line managers of the enterprise was wholeheartedly accepted. It resulted in the day-to-day involvement of the general manager of the Factory No. 1, managers of the organization department, engineering department, technological department, the chief production engineer, and the economic director.

The level of the specialist counterparts was generally excellent. Their understanding of theoretical systems concepts was good. They adapted rapidly to the many new ideas introduced and set out to apply them with enthusiasm. As earlier mentioned in this report it was, initially, with great difficulties that permanent representatives from the user departments were found for work assignments on the project. In the end, however, their contribution to its success turned out to be the most unexpected and, relatively seen, the most valuable.

Worth mentioning, as indicative of the desire to more directly associate with the United Nations experts on the part of the national counterparts, was their voluntary participation in an English language course. This course was presented outside normal working hours by one of the translators on the project

on his own initiative. Outside the preparation time involved for the lectures it included approximately 300 sessions of 45 minutes each. Both the interpreter who took this initiative and the counterpart participants deserve to be highly commended for their efforts.

In broad terms the educational objectives of the project were achieved. The only major shortcoming being that the stage of actual implementation and parallel running/cut-over of the new system was just not reached. This phase presents another set of peculiar problems and for the sake of completion of the counterparts' training occasional exposure to outside expert assistance during that phase would still be highly desirable.

A list of project personnel and a list of the system's users are given in annexes V and VI.

II. RECOMMENDATIONS

Recommendations are divided into four major groups:

(a) Reorganization of organization section;

(b) Hardware support:

Short term
Intermediate term
Long term;

(c) Programming support;

(d) Continued short-term consultancy support.

A. Reorganization of organization section

The new approach accepted by EVIG to systems development and the associated computer technology makes it necessary to gear the organization section accordingly. This requires an upgrading of the section to full corporate department status and a redefining of its tasks. By-products of such reorganization would certainly be increased credibility and acceptance of the department's activities amongst the line managers, and improved career possibilities for the department's personnel.

The organization section and its organizational structure have evolved over a large number of years to their present status. The result of this evolutionary process is that the section now represents a number of glaring anomalies and organizational contradictions. Some of these are:

(a) Contrary to other major corporate functions such as design engineering and material management, the organization function has never been raised to the full status of a corporate department, but remained a staff section to the Director General. This is now seriously affecting the orderly control and management of its functions owing to the lack of depth of the management structure;

(b) There can now be defined three distinctly different groups of functions presently performed by the organization section:

(i) Those dealing with computer systems (design/programming/operation). Mainly subcontract work for the line operation of the corporation;

(ii) Those dealing with the office of the Director General (administrative advice industrial psychology etc.);

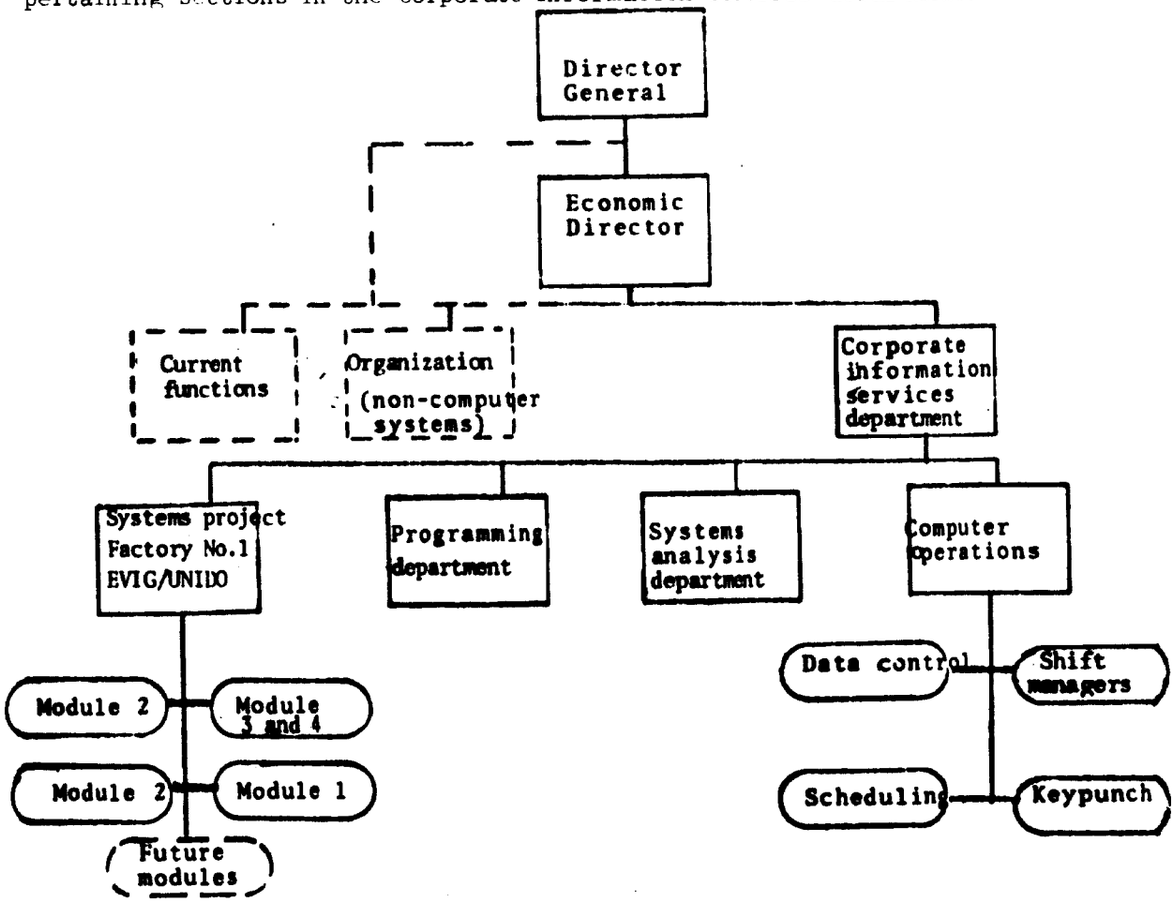
(iii) Those of a general service nature, sometimes even line functions (telephone lines, forms design, material cataloguing etc.).

This wide variety of functions and responsibilities, essentially belonging in different management spheres of the corporation, frequently poses serious decision conflict situations.

It is recommended that a new department, the Corporate information services department, be created, split off from the present organization function. It should obtain full department status and be assigned all responsibilities for computer systems analysis, programming and computer operations. It should report to the Economic Director. It is further recommended that the organization section remains with its other functions (except those of a purely line responsibility nature) and either continues to be a staff section to the Director General or is also transferred to the Economic Director (see figure below).

Within the new Corporate information services department project teams should be organized to develop major systems projects, such as the current EVIG/UNIDO project. (A natural area for the creation of an additional project team is at the present the entire area of terminals, data entry and mini computer capabilities.)

Upon completion of projects and transfer of systems to users the operating personnel teams should be dissolved and the members returned to their pertaining sections in the Corporate information services department.



B. Hardware support

The difficulties encountered by industrial enterprises in Hungary in the areas of securing the proper hardware are sufficiently recognized by this UNIDO team. Once, however, EVIG made the decision to embark on the implementation of much needed management and control systems, it has to, logically, give serious consideration to the following recommendations all directed at assuring the necessary hardware support for these systems.

Short term

It is recommended that EVIG develop immediately a working arrangement with a second non-EVIG organization for additional computer time. The second non-EVIG organization should have its own "working" computer of the RIAD-30 series or have an IBM/360 or IBM/370 configuration. This arrangement would help to alleviate the present deficiencies in the KG-ISZSZI/EVIG collaboration. At present EVIG programmers have great difficulty in obtaining machine time for testing and compiling their programs. This problem is affecting the progress of the project. Immediately upon implementation of the first systems module, stagnation in the computer support at KG-ISZSZI would have serious effects on the running of EVIG's manufacturing activities. Pre-arranged back-up support is therefore a must.

It is further recommended that EVIG increase its computer center keypunch capacity. With its present equipment this is a manpower problem. All future source data must be keypunched within EVIG to develop and retain control over the data entry functions of the new system. In addition, however, EVIG should obtain access to keypunch equipment for programming purposes. Its present equipment is not compatible with the programming requirements.

Intermediate term

It is recommended that EVIG create long-term access to an off-site computer of the type RIAD-30, IBM/360 or IBM/370 by means of a data entry terminal. This would be a satisfactory alternative arrangement to the long-term recommendation that EVIG obtain its own in-house configuration compatible with the systems requirements. The recommendation is subject to a number of conditions:

(a) The off-site computer is reserved for EVIG for a minimum of one shift dedicated machine time;

(b) Proper quality telephone lines between the computer and the data terminal at EVIG;

(c) The data terminal support card as well as tape input;

(d) The data terminal have high-speed printer interface support;

(e) EVIG be able to arrange a minimum of five years commitment for these computer services.

It is recommended that EVIG create a small project team to develop user terminal support for direct data entry. The current card input approach orientation of the system is seen only as an intermediate phase in the system. It was used only, because the available hardware (terminals, data concentrator) was not made operational during the life of this project. Informal requests to replace the current card input approach by direct user terminal input have justifiably been made by the Central engineering department and the Technological department. It is certain to come from the Material department as well, when they too recognize the disadvantages of the current card input approach.

Long term

It is recommended that EVIG on the strength of its systems experience gained during this UNIDO project and during its co-operation with hardware support organizations reassess its need for an in-house computer configuration compatible with its systems needs. This computer should be supported by a complete array of operating and application software. If EVIG in the future, as is now clearly foreseen to take place, extends the systems approach, introduced by this UNIDO team, to all its manufacturing divisions, it seems economically justified that it obtains a computer that will adequately serve that purpose.

C. Programming support

During the life of the project it has become sufficiently clear that it is difficult to find a workable arrangement whereby a large part or all of the programming work can be subcontracted to outsiders. Even the relatively minor task to adapt the program package BOMP met with delays and communication problems between EVIG and its subcontractors. Ideally EVIG should for some years to come have access to at least 10 experienced and well trained high level language programmers for the sole purpose of getting its MIS on the road. It is well understood that these cannot be found on the Hungarian labour market. The alternative is to train them in-house.

It is therefore recommended that EVIG increase its attempts to hire theoretically well trained programmers, without decreasing its attempts to engage practically experienced programming personnel as well.

During the past 12 months of the project EVIG has hired two junior programmers, recent college graduates, who are well trained and became rapidly productive. This kind of resources are needed to continue development, provide future maintenance support for the EVIG systems and become eventually independent of outside programming support. These programming resources would form the only means by which the system could eventually be transferred to EVIG's own computer.

In view of the need for programmers for the integrated systems now developed for EVIG, it is recommended that EVIG suspend all non critical programming efforts directed towards currently installed systems.

D. Continued short-term consultancy support

The UNIDO project at EVIG has resulted in a large number of profound changes in the organization. The beneficial effects of these changes will not come automatically. Although the point has been reached where implementation of some modules of the system can now take place, this implementation was planned to take place at least partly during the life of the UNIDO project. Reasons for the delays are sufficiently elaborated upon in other sections of this report.

It should be recognized that a large task still remains after current modules and the data base are operationable. That is the task of adapting and implementing the remaining modules of PICS and the completion of user manuals and user training.

In order to assure that all further activities are carried out in keeping with the established systems architecture it is recommended that EVIG, in co-operation with the Ministry of Metallurgy and Machine Industry assure the further assistance of outside consultants. Ideally, approximately every 3 months during a period of the next 12 months, 4 man-weeks of such outside consulting should be assured. The impact this short UNIDO project has had is sufficient support for the practical effect such consultants would have.

III. CONCLUSIONS

In conclusion, a few words about the actual results of the project. The project was one of transfer of technology. Its success is difficult to measure in quantitative terms, partly because no absolute means for such measurement are yet available (in this field) and partly because the results are long term. Nevertheless, some demonstrable facts indicative for the impact the project has had should be cited:

(a) EVIG has become committed to integrated systems development as a powerful tool to improve its economic performance by means of more direct control over its activities;

(b) EVIG's line managers understand the technology underlying integrated systems and strongly desire implementation;

(c) The team of counterparts associated with the project have literally leap-frogged into systems design efforts on a par with those anywhere in the most sophisticated areas of the industrially developed world;

(d) Systematic and efficient institutional systems support to industrial enterprises in Hungary is weak. EVIG has risen to this challenge and its systems group is now confidently applying the help-yourself-method;

(e) With some minor additional efforts the following systems modules are ready for implementation:

Module B/R-I	Creation and maintenance of product structure and item master files
Module D/E	Standardized data entry
Module P/I	Physical inventory
Module print	Uniform management report print capabilities
Module conversion-data	Transfer from existing tape files to integrated new disc files

(f) In addition the work on module B/R-II (technological master files creation and update) has progressed to the detail design phase;

(g) Up-to-date systems design methodology has been implemented in EVIG including standards for:

Documentation

Programming

User manuals

Project management

A key preparatory activity to a major systems design project is the selection of hardware. This project started too late to have an effect on EVIG's choice. The choice (EMG 840), although in itself probably good, was not

compatible with EVIG's need in the area of software and its urgency in obtaining systems implementation in a short period of time. This incompatibility resulted in the largest single peripheral effort exerted by this project. Extensive research had to be done to locate alternative machine time and software support. To this moment this problem has not been solved in an entirely satisfactory manner. The further development of systems will seriously be hampered unless a satisfactory long term solution is found.

Regrettably, the project stopped just short of implementation of not one but four systems modules. The reasons for this are sufficiently defined in the body of this report. There is no doubt, however, that if and when EVIG decides to assign the responsibility to prepare source documents and start loading the data base master files, startling results will be obtained rapidly. The retrieval possibilities offered by modules B/R-I and B/R-II go far beyond current reporting capabilities and should offer vastly improved management control and reaction time.

The first activity to be undertaken upon completion of the product structure and item master files is the implementation of the physical inventory module. Although no optimization of investment could be achieved with this module, it allows certainly a control method that would show monetary improvement within months after implementation.

Assuming that EVIG carries out the recommendations contained in this report, it is foreseen that the entire system, including all PICS modules can be implemented towards the middle of 1977. This would be a break-through in Hungarian industry. EVIG would thus certainly represent a model for systems implementation.

The educational part of the project was undoubtedly carried out with success. EVIG has now access to a team of systems analysts, who should be capable to carry on the work started with only minor and occasional outside assistance. Sooner or later the snowball effect of this knowledge is going to be felt when the work started in Factory No. 1 is continued in the other enterprises of EVIG.

Aside from the actual systems design results achieved by the project, special mention should be made of the effect the project has had on line managers and their understanding of their function in the design and use of computer systems. This fact coupled with the proposed reorganization of the organization department could well have the most important effect on the enterprise resulting from this project.

The writer would like to specifically mention the support for the project's activities from Mr. F. Talyigás, General Director in the Ministry of Metallurgy and Machine Industry (KGM). The project was conceived by him, and he provided at times of difficulties often the decisive solution and new direction.
Mr. Talyigás untimely death on 3 March 1976, was experienced by all as a severe loss.

Annex I

OUTLINE OF THE SYSTEM DESIGN COURSE

1. The industrial organization (interdepending of functions)
2. The role of management services
   Systems analysists
3. Project management
   - Elements of a systems project
   Cost/benefit analysis
   Project documentation
   Progress control methods
   Budgets
   Network planning
4. Basic hardware - feasibility study
5. Fact and data gathering
   The human elements (resistance to change)
   Interview techniques
   Presentation techniques
   Charting
   (a) Systems flow charting
   (b) Program flow charting
6. Decision tables
7. Product flow analysis
8. Information flow analysis
9. Systems documentation
10. Systems design
    Evaluation of existing product and information flow
    Identification of new systems requirements
    Output/input design
11. Forms design
12. Coding systems

13. File design
    - File structures
    - Sorting
    - Searching
    - Disc files - tape files

14. Data base design
    - Principles of integrated systems
    - Complex file structures
    - Data base management

15. Preparation of systems description

16. Training of users
    - Management orientation
    - Users training

17. Operating manuals

18. Systems conversion
    - Program conversion
    - File conversion

19. Systems audit and evaluation

20. Systems maintenance

Annex II

RECOMMENDATIONS ON EDP SUPPORT

A review of data processing support offered by various Hungarian state agencies has been made. A further understanding of the data-processing resource capabilities within EVIG has also been established. These reviews and understandings have been made in a brief period of time via a language translation process in which a full understanding of all relevant ramifications could not be established or understood. As a result, the following action is recommended:

1. That manufacturing computer application package be employed in the development of the EVIG manufacturing planning and control systems. Specifically, that the application package systems offered be either ICL - NIMMS (Integrated Modular Management System) or IBM's - BOMP (Bill of Material Processor - Program Product Version) and MRP (Material Requirement Planning) system be choosen for use within the EVIG enterprise.

2. That the EVIG management conduct further negotiations with SZAMOK (IBM/BOMP/MRP) and NIMIGUSZI (ICL-NIMMS). The purpose of these negotiations is to obtain the most favourable programming support and hardware support conditions. As a result of these negotiations, EVIG should then retain the organization via appropriate means.

3. Depending upon who is selected in point 2 above, that EVIG secure back-up support from either the Hungarian State Agency known to us as OVK (ICL) or SZÜV (IBM). Their back-up support should provide additional programming resources and computer machine hours if sufficient resources were not available at the primary source.

4. EVIG should provide the selected Hungarian representative (either NIMIGUSZI or SZAMOK) with two programmers trainees. These two programmers trainees should be trained by the selected representative in the programming aspects of the manufacturing information systems of EVIG.

Annex III

GENERAL SYSTEMS ARCHITECTURE FOR EVIG[a/]

A. Systems architecture

The EVIG/UNIDO system is based upon a systems architecture approach used successfully in thousands of manufacturing organizations throughout the world. While each of these organizations has its own unique system, each system has evolved or been built around a common set of general approaches.

The basic principle is to be able to compare end item requirements with supplied and manufactured items. A second principle is to be able to produce these end item requirements on time with a minimum of plant capacity, i.e. labour, space and tools. This capability of comparing requirements with inventory exists in a computer system module referred to as "material requirements planning - net". To make this system module work the organization has to develop a foundation. This foundation takes place in the form of a data base. To build the organizational data base many subsystems or system modules must be first developed and installed. Section B briefly outlines these modules.

Figure I illustrates the fundamental principle of the system. Demands (S) are compared to inventory (K) by the requirements planning module. Out-of-balance situations are the rule (demands versus inventory are normally not equal). The comparison is done for each planning time period - normally a month - for as many as 18 to 30 time periods. To achieve a balance between demands and inventory, action must be taken. The EDP system module makes recommendations which, if followed (and if good data base data exists), will restore a balance for each time period.

Figure II illustrates the over-all architecture of the system. Each group description identified on the illustration represents a system module or key output from a system module. Reference to section B should provide the reader with enough general information to form a basic understanding of the proposed EVIG/UNIDO manufacturing control system.

[a/] Prepared by D.L. Morris, expert in systems analysis and design.

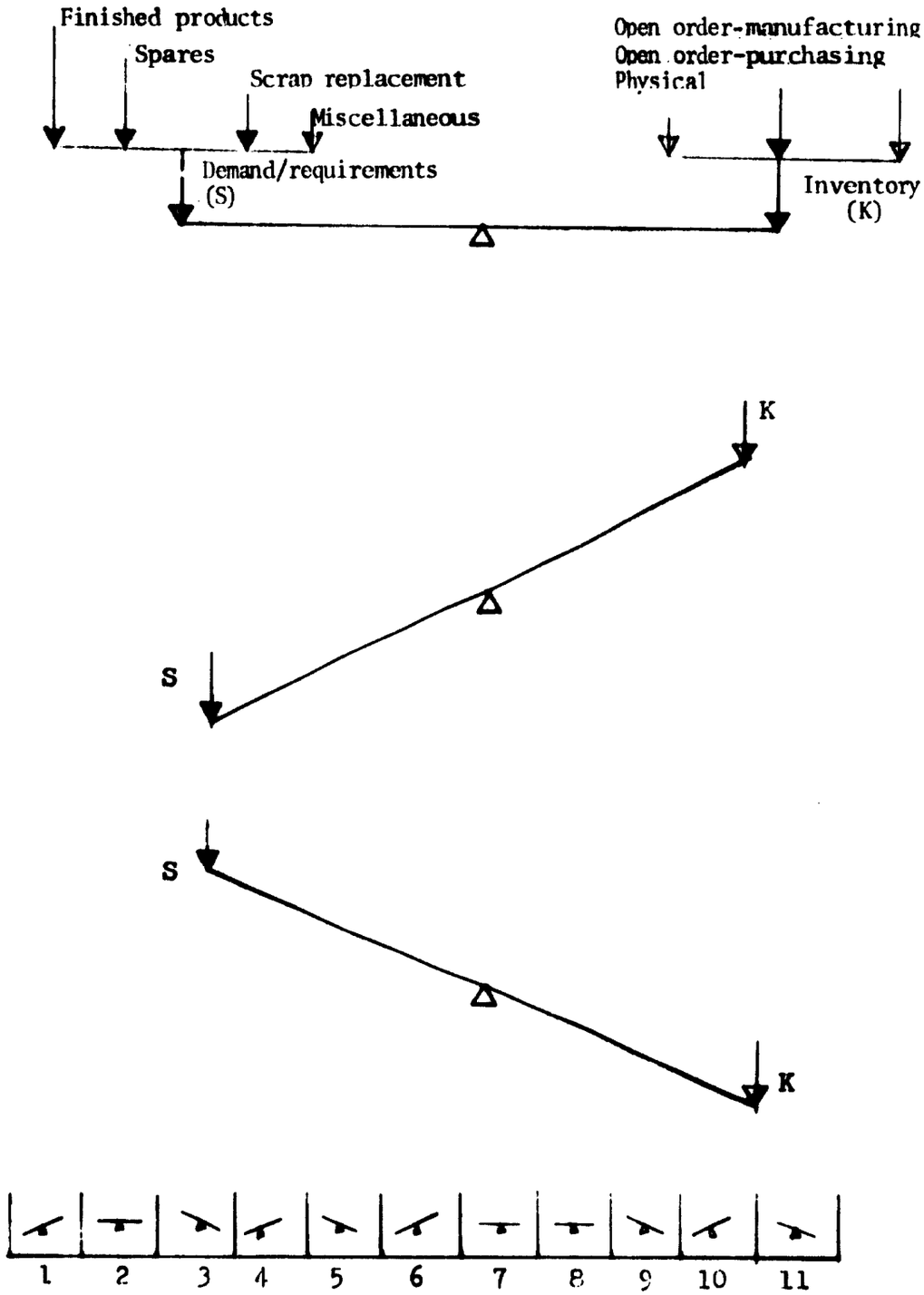


Figure I. Manufacturing planning and control system.
Computer summary view

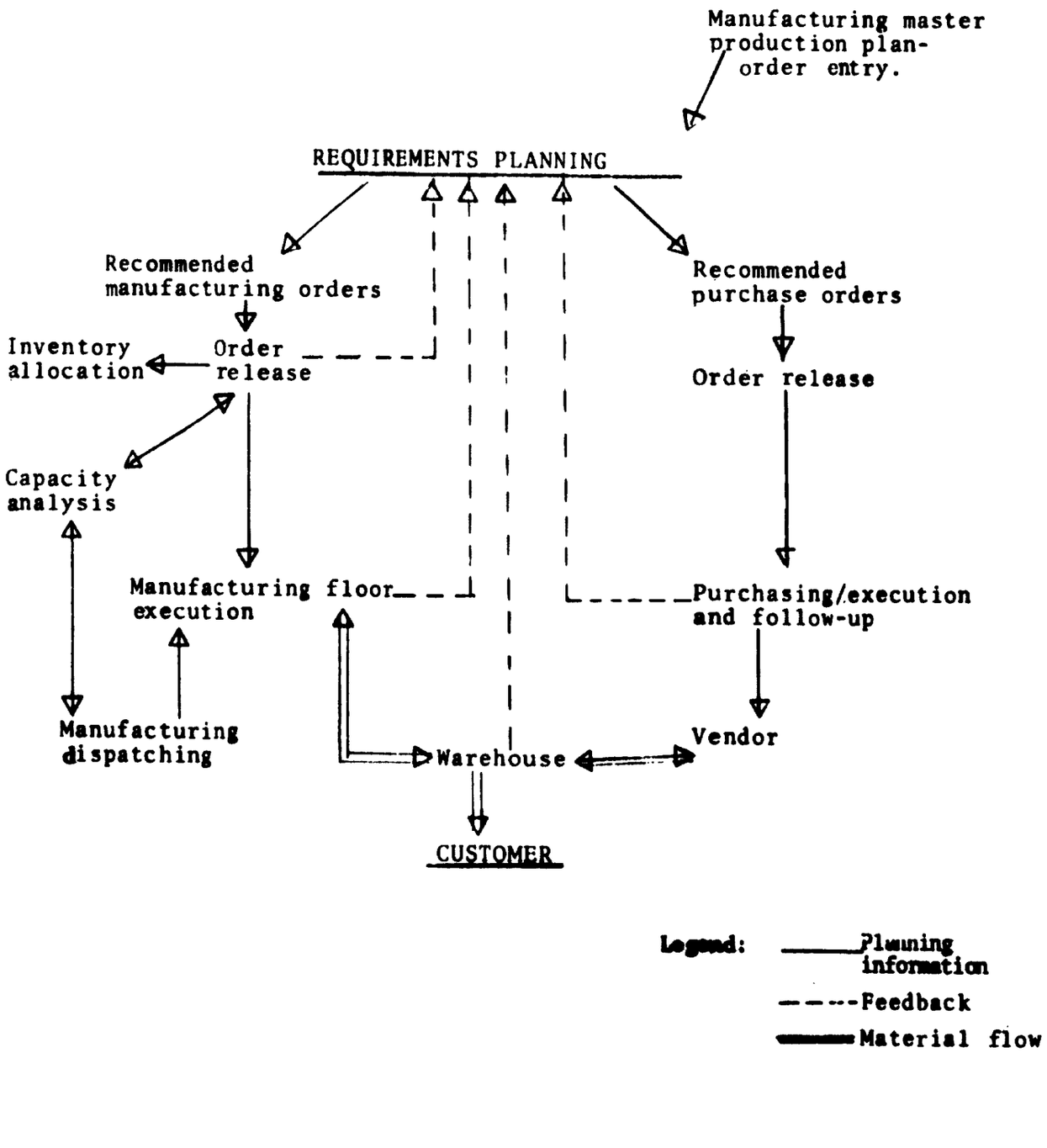


Figure II. Manufacturing planning and control system. Computer application/module interfaces

B. Systems module description

List of systems modules

1. Basic records-I
2. Basic records-II
3. Basic records-III
4. Common data entry
5. Common print
6. Physical inventory
7. Material requirements planning - gross
8. Material requirements planning - net
9. Order release
10. Manufacturing floor control
11. Purchasing/collaboration
12. Inventory allocation
13. Capacity planning

1. Basic records - I module: (a) Creates and maintains descriptions of manufactured items, i.e., details, assemblies, castings and purchased parts on an exception basis; and (b) creates and maintains descriptions of product structures, i.e., bills of materials.

2. Basic records-II module: (a) Creates and maintains description of manufacturing processes, i.e., manufacturing routings; and (b) identifies what capacity (labour and machine tools) is required to manufacture a unit's worth of product.

3. Basic records-III module: (a) Creates and maintains descriptions of raw material and purchased parts; and (b) supports statistical forecasting of raw material and purchased part items.

4. Common data entry module: Provides a singular approach to entering all user source data into the EVIG manufacturing control system.

5. Common print module: Provides a singular approach to printing all computer reports.

6. Physical inventory module: (a) Captures and reports to the system data base all physical movement activity in EVIG's warehouses; and (b) is concerned initially with all Factory No. 1 warehouses and the EVIG central warehouses.

7. Material requirements planning - gross: (a) Forecasts long-range EVIG end item (final assemblies, spare parts, etc.) requirements; (b) in time-series fashion, generates gross (physical inventory and released open orders not considered) requirements for manufactured assemblies and details and for purchased items; and (c) supports the entry of firm customer orders into the EVIG manufacturing system.

8. Material requirements planning - net: (a) Is an extension of module 7; and (b) in time-series fashion generates net (physical inventory and released open orders are considered) requirements for manufactured assemblies, details and for purchased items.

9. Order release module: (a) May be developed in two major steps. The first step is without material requirements planning support, i.e. output. The second step is with output generated by a material requirements planning net module; (b) generates manufacturing work orders (routings); (c) creates a manufacturing "load" file, i.e. a description of work in process; and (d) creates material requisitions to authorize the warehouses to issue material to the manufacturing process.

10. Manufacturing floor control: (a) Tracks (reports) the status of manufacturing work orders; and (b) generates a periodic dispatch work list. This dispatch work list provides, in priority sequence, a list of work for each controlled cost centre/work centre.

11. Purchasing/collaboration module: Tracks (reports) the status of purchase orders.

12. Inventory allocation: (a) Preallocates (stages) inventory to released manufacturing orders; (b) allocates on a priority basis; and (c) schedules warehouse requisition activity.

13. Capacity planning module: (a) Analyses EVIG manufacturing plans against plant capacity profiles; and (b) does analysis with finite and/or infinite EVIG capacity profiles.

C. Data base architecture

Figure III provides an illustration of the many and varied interface relationships between the EVIG/UNIDO system modules and data base files. The relationship between system module and data base file indicates which system module creates or maintains the particular data base file. The order of system modules (top to bottom) is a general sequence of development. The lines between data base files indicate what logical interrelationship of data will exist between one or more files at any given point in time. Each data base file has a unique set of data elements. These files contain the following general categories of data:

Item master description: This file provides a description of each item category within the system. Raw material is included on an exception basis.

Product structure description: The logical relationship between items which make an assembly or detail is defined by this file.

Process description: The process or procedure by which an assembly or detail is made is described in this file.

Raw material description: This file provides a description for each raw material and purchased item within the system.

Subordinate item master: This file provides information regarding physical stock balances by location, summarized open order information, summarized EVIG and item requirements and summarized planned orders.

Customer order/forecast plans: This file provides specific information regarding customer orders and long-range end-item forecast plans.

Manufacturing load file: Work which has been released to the manufacturing process is described in this file. As work is finished the load of work remaining is reduced. Short-term capacity requirements are defined in this file.

Warehouse requisitions: Demands for items stored in the warehouses are contained in this file. These demands, when presented to the warehouse, provide the authority for the warehouse to issue material.

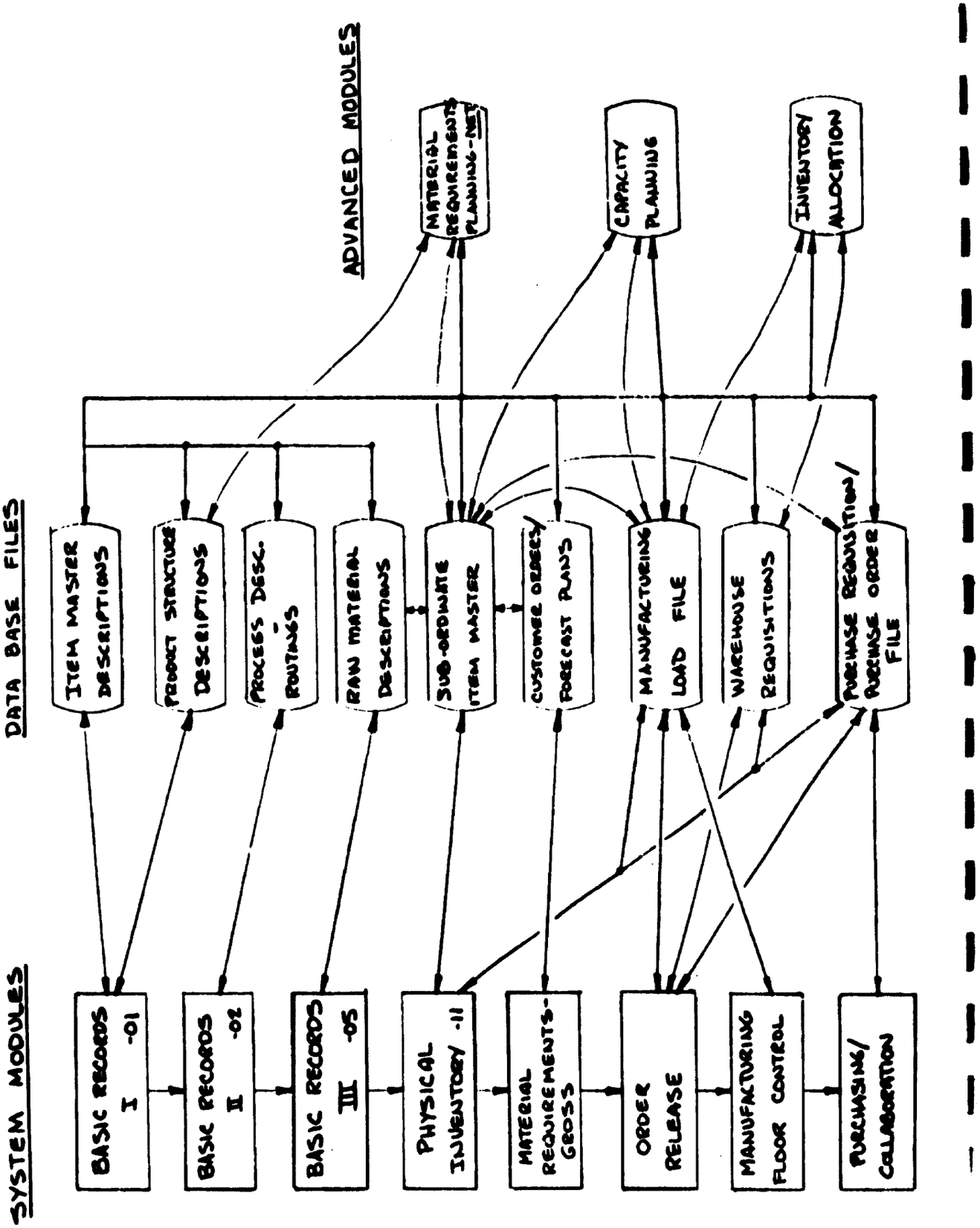


Figure III. Data base architecture

Purchase requisition/Purchase order file: This file contains requests for items from the plants to the central purchasing function. Purchase orders are placed on this file as items are purchased.

D. Development sequence

The development of an integrated manufacturing control system with many modules requires an ordered process of development. The list below identifies the modules and the order in which development most logically should proceed. EVIC resource availability and priorities should determine which modules should be developed when alternatives exist.

Sequence	Module name
1	Basic records-I, common data entry, common print
2	Basic records-II, physical inventory
3	Basic records-III, material requirements planning - gross
4	Order release - step 1, manufacturing floor control, purchasing/collaboration
5	Material requirements planning - net order release - step 2
6	Inventory allocation, capacity planning

Annex IV

MIS DEVELOPMENT PROCEDURE

The project development procedure used at EVIG represents a modified (simplified) approach to simultaneous multiapplication development. The approach has proven its success in industry universally, in medium and large EDP development projects, using variation of the same development procedure.

This project commenced at a point where major decisions had previously been made. These decisions greatly simplified the project development procedure required during 1975-1976. Key decisions made at the start of the project were:

(a) There would be a computer-based manufacturing planning and control system;

(b) It would be developed in a modular fashion;

(c) IBM PICS methodology was the general framework in which development would take place;

(d) Resources would dictate the breadth of development areas and material planning and control had a greater priority than fiscal planning and control. With this background the following approach to system development was promoted and used.

Development of each system module follows a phased development approach. Each phase is fully documented. Each phase requires formal management review and agreement prior to starting the next phase. Ideally, projected costs and benefits resulting from eventual development of the submodule are reforecasted at the end of each phase step. Management, in light of their priorities and resources available to commit to the project, make their decisions.

The phases are (for the EVIG situation):

1. General design
2. Detail design
3. Programming/testing
4. User preparation
5. Implementation
6. Operation

Phase 3, which follows the completion of phase 2, is finished prior to starting module implementation - phase 5. Phase 4 parallels phase 2 and 3 and overlaps into phase 5. During the course of phase 4 the user representatives to the development group are engaged in the following type activities:

(a) Source document forms design review and decision;

(b) Creation of source document instructions;

(c) Maintenance of data element dictionary;

(d) Creation of system (module) procedures;

(e) Education support of user groups (workers);

(f) Council systems analysts, programmers and others in the realities of the "real world".

Phase 5 lasts for a predetermined period of time. The system is considered installed at the end of this phase when pre-established installation criteria are satisfied. Phase 6 starts after completion of phase 5. Phase 6 is the period in which operational use of the module takes place. Modification to installed systems, the control procedures used, etc., were not part of this project.

Annex V

PROJECT PERSONNEL

A. UNIDO experts

Name	Field	Contract dates
F.G. de Jong	Industrial management and organization project manager	January 1975 to Approximately 1976
D.L. Morris	Systems Analysis and Design. Computer-based manufacturing systems	March 1975 to Approximately 1976
H.D. Klette	Operation research/ computer programming	March 1975 to September 1975
B.K. Agrawal	Senior industrial management expert	6 June 1975 to 19 June 1975 6 March 1976 to 19 March 1976

B. Counterpart personnel

Name	Position
Sándor Domby	Economic director
László Viosz	Technical director
József Batta	Chief production engineer
I. Szenohradszky	Chief engineer, engineering design
Zoltán Lefter	Chief engineer, manager of the electric machine factory
Károly Végvári	Head of central organization section
László Kovács	Systems analyst
Natasa Laczkó	Systems analyst
Sándor Solti	Systems analyst
Tibor Tordai	Systems analyst
Mária Tóth	Systems analyst
Zsófia Juhász	Programmer
Károly Kiss	Programmer
Erzsébet Petróczy	Programmer

Gabriella Reményi	Programmer
László Ság	Technical interpreter and systems analyst
János Sarlós	Technical interpreter and systems analyst
Endre Forrás	Protocol officer
Judit Lehner	Secretary and interpreter
Katalin Németi	Typist
Endre Várkonyi	Interpreter

Annex VI

USERS OF THE SYSTEM

Name	Title	Station
Andor Bajnok	Head	Central material supply department
István Bakonyi (former)	Chief accountant	Electric machine factory
Béla Dobos (present)	Chief accountant	Electric machine factory
József Zimányi	Head	Technical department
Tibor Leitgéb	Head	Production department
János Jaczina	Head	Manufacturing equipment
Vince Hanriscsák	Head	Production control
Lajos Paizs	Head	Production scheduling
Elvira Bogács	Head	Plant economy section
Margit Leitgéb	Head	Calculation section
Erzsébet Both	Head	Accounting section
Gyula Mátyássy	Engineer in charge of computer centre	Organization section
László Kuracz	Programming group leader	Organization section
Ferenc Harsányi	Cief foreman	Electric machine factory Plant No. 3
István Noszkó	Technologist	Electric machine factory
László Kiss	Design engineer, group leader	Central engineering
Imre Pintácsi	Head	Electric machine factory Technology section
Ferenc Puszti	Head	Electric machine factory Material supply section
Ferenc Szovényi	Head	Central pre-calculation and prices section
László Szilos	Head	Central warehousing section
Mária Mazányi	Head	Central warehouse
Erzsébet Farkas	Group leader	Central material supply
Mária Pataki	Requirements planner	Electric machine factory, material supply
Árpád Balázs	Head	Electric machine factory production preparation
Pál Orbán	Technical secretary, mathematical norms expert	Central engineering

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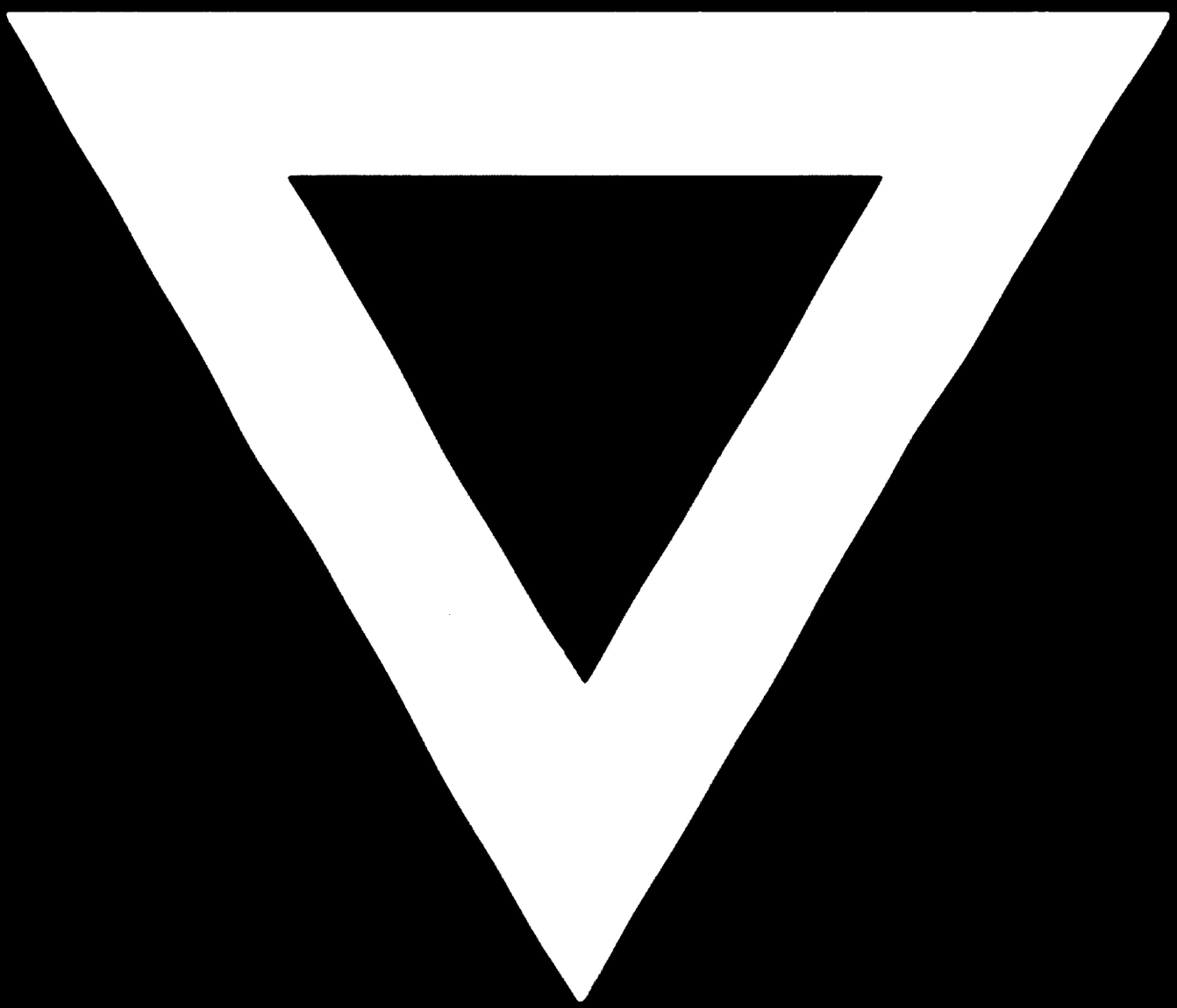

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