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

IR/HUN/74/010

HUNGARY.

Technical report:
GENERAL DESIGN SPECIFICATIONS

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

[redacted]

United Nations Development Programme

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United Nations Industrial Development Organisation
Vienna, 1976

Explanatory notes

The following abbreviations are used in this report:

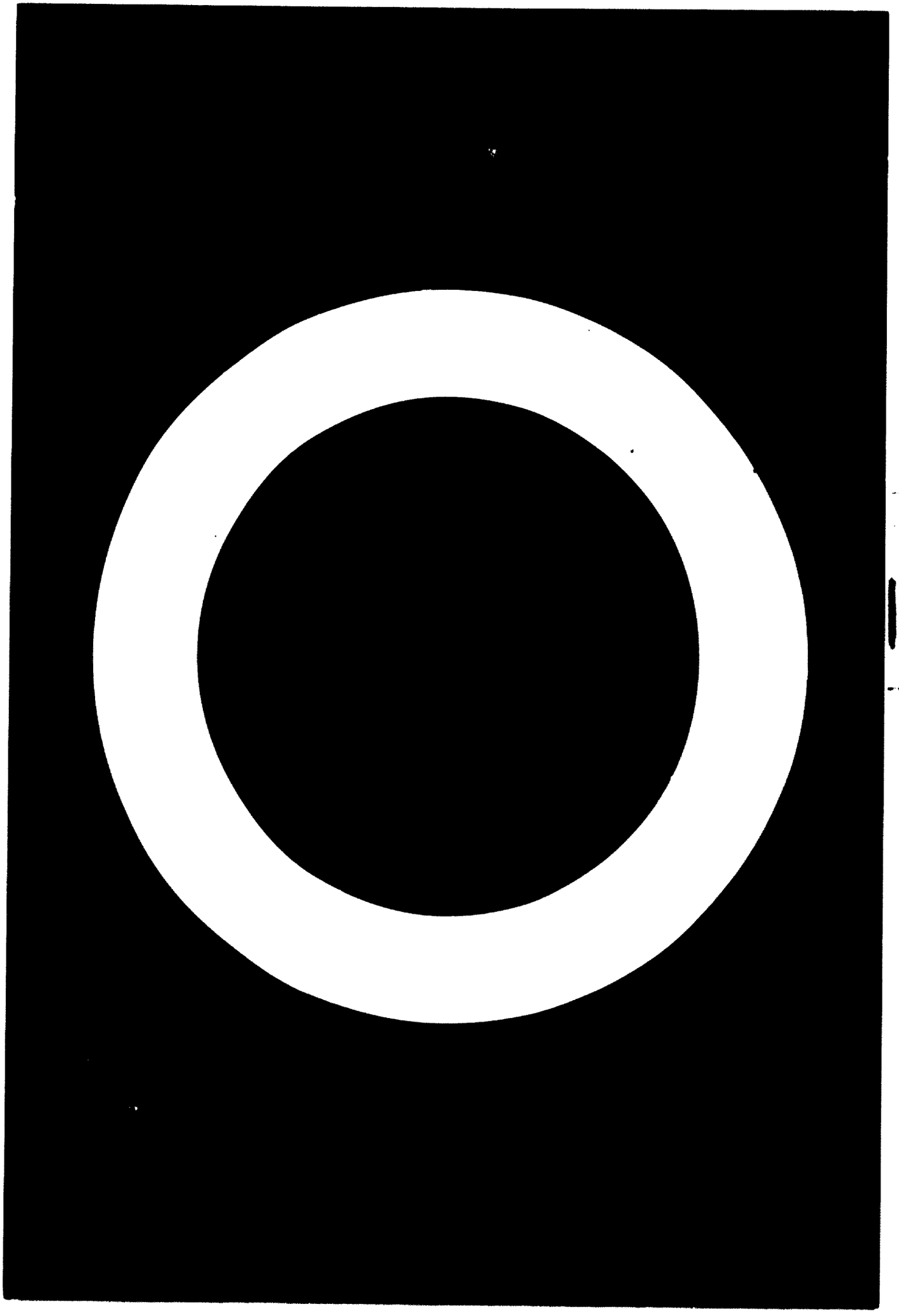
CPU	Central processing unit
EDP	Electronic data processing
EVIG	Egyesült Villamosgepgyár (United electric machine works)
SFC	System flow chart

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 project was officially requested by the Government of Hungary on 4 October 1974. It became operational on 9 January 1975 and 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.

The enterprise, EVIG, is a major manufacturer of electric motors and equipment. It has nine manufacturing units and produces a wide range of electric motors, hand tools, cable fittings, ferrous and non-ferrous castings, industrial electronics and electrical equipment.

This technical report describes a number of electronic data-processing application modules, i.e. basic records-I, basic records-II, common data entry, common print and physical inventory modules. The documentation standards are also described.



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INTRODUCTION

The project "Design of a Computer-Based Manufacturing Control and Information System for an Enterprise Producing Electric Machinery" (IS/HUN/74/010) is a continuation of an earlier project (IS/HUN/72/803). The United Nations Industrial Development Organization (UNIDO) was the executing agency for both projects. This report describes a number of electronic data processing (EDP) application modules that will form the architecture of a new computer-based integrated production management system for the enterprise EVIG.

EVIG is a major manufacturer of electric motors and equipment. It has nine manufacturing units and produces a wide range of electric motors, hand tools, cable fittings, ferrous and non-ferrous castings, industrial electronics and electrical equipment. The enterprise has access to third generation computing equipment.

The project results from the high priority that management has given to organization and information systems design. The company wants to improve its organizational structure and line of control through the implementation of an integrated management and control system, broadening simultaneously its in-house systems design competence.

The growth and demands for hardware and software for manufacturing control systems have increased steadily in industry during the last 20 years. Today, most of the large manufacturing companies have designed or are in the process of designing their own computer-based manufacturing control systems.

Thus, the main objective of the project was to design a manufacturing control system including the generation of major records and files. After the general outline and module priority were established, the project team was divided into smaller groups, each responsible for a phase of general design, detailed design and implementation of the modules. In designing the data base modules, care was taken that all usable data from the existing system should be captured and transferred to the new system.

I. DOCUMENTATION STANDARDS

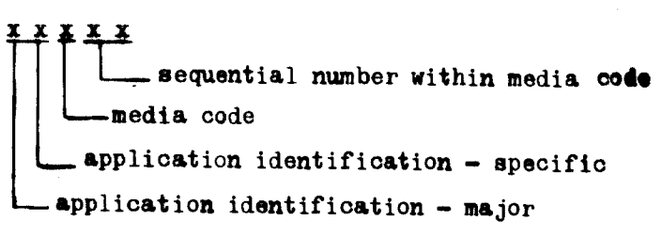
Each specific application (module) should be supported by a set of documentation. This documentation is first created for the general design phase. The level of detail increases as the development phases take place.

A. Documentation contents at the end of each phase

Item	General design phase	Detail design phase	Programming phase	Implementation phase
1. Narrative	x	x	x	x
2. System (module) flow chart	x	x	x	x
3. Source input document	x	x	x	x
4. Report outputs	x	x	x	x
5. Card file layouts		x	x	x
6. Tape file layouts		x	x	x
7. Disk file layouts		x	x	x
8. Program functional narrative		x	x	x
Logic diagrams			x	x
Test data			x	x
Program source			x	x
Listing			x	x
Timing information			x	x
9. Application qualitative data	x	x	x	x
10. Keypunch/verify instructions			x	x

B. Documentation numbering guide

Format



Major application code

0 - Basic records/data entry

1 - Physical inventory/order entry/material requirements planning

2-8 - Not assigned

9 - Computer centre use

Specific application codes

01 - B/R-I - Basic records-I (item master, subordinate item master, product structure)

02 - B/R-II - Basic records-II (master routing)

03 - Data entry

04 - Common print

05 - B/R-III - Basic records-III (raw material, purchased parts, item master)

11 - Physical inventory

12 - Inventory planning (item types 3 and 4)

15 - Material requirements planning

Media code

1 - Source document

2 - Card file

3 - Program

4 - Tape

5 - Disk

6 - KP/ver

7 - Paper tape

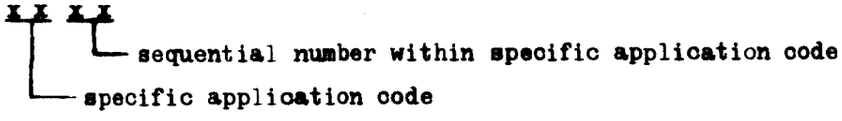
8 - Report output

Number assignment - general interface role

The specific application creating the file, report, program etc., is responsible for establishing the document number.

C. Transaction numbering guide

Format



General

Transaction codes are assigned to add, change and delete records or data elements within records. Transaction numbers should be assigned so that when utility sorting is performed on the transaction numbering field the resulting sequence is: add; change; delete.

II. BASIC RECORDS-I MODULE[1/]

A. Narrative

An integrated manufacturing control system - computer based - is created from numerous subsystems. These subsystems are referred to as applications or modules. The B/R-I module is the first computer subsystem to be developed and implemented within the EVIG/UNIDO manufacturing control system. The narrative portion of the B/R-I documentation presents a broad description of the module. This narrative tries to answer fundamental questions that are considered most likely to be asked by the reader. These questions are:

What is the B/R-I module?
Why this module?
Who are the users of this module?
Module execution.
When is the module used?
How does the module work?

What is the B/R-I module?

This module represents the beginning EDP application module within the EVIG EDP manufacturing control system. This module provides a foundation for further EDP expansion of the manufacturing control system. With this module the user[2/] establishes on computer files the basic information elements of an integrated manufacturing control system. Basic information elements are referred to as data elements in computer terminology.

A manufacturing control system requires three categories of basic data elements. These categories of basic data elements are:

(a) Item descriptions;
(b) Product structures;
(c) Process descriptions.

This application module and basic records-III support the first category of basic data elements. The second category of basic data elements is supported

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1/ Systems analysts: Dan L. Morris, UNIDO; István Noszkó, EVIG; Sandor Solti, EVIG; Balázsné Tóth, EVIG.

2/ User is a broad term used to identify the management and workers who actually use the system. It excludes the personnel within the organization department unless otherwise specified.

by this application module. The basic records-II application module supports the third category.

The users of this module are categorized into two groups:

(a) Central engineering/material norms;
(b) Plant technolog (manufacturing engineering).

These two user groups are responsible for creating source documents and reviewing the resultant computer created output reports.

Design of this module supports source data input from both of these user groups. That is, both user groups are able to put into the manufacturing control system basic data elements that reflect that user's fundamental data processing requirements.

Briefly the three categories of basic data elements may be defined as follows:

Item descriptions are a collection of data elements that remain, in general, fixed. This means that customer orders, work orders, etc., have no impact on this collection of data elements. This fixed set of data is defined in the system one time per each unique item (part number). This fixed set of data is further defined in only one system location, i.e. the item master file.

Product structures exist at EVIG in the form of a bill of material created by central engineering. These bills of material serve the documentation objectives of the central engineering organization. A computer-based manufacturing control system requires a bill of material or product structure that satisfies several manufacturing objectives. As is often the situation, the objectives of an engineering organization are not the same as those of a manufacturing organization. Manufacturing product structures define the actual process by which (a) details are made from raw material, (b) subassemblies are made from details and other subassemblies; and (c) finished motors are made from subassemblies, details and raw materials. The module B/R-I supports computer-created product structures that satisfy the documentation objectives of cental engineering. It also provides the means by which the plant technolog organization can create a manufacturing product structure. It is recognized that this function is not presently performed at EVIG. Several alternatives exist as to who and how a manufacturing product structure can best be estab-

lished. It is, however, the firm recommendation that the plant technolog be the responsible organization to execute this task. It must be clearly understood that a manufacturing product structure is prerequisit to a current technology computer based manufacturing control system.

Process descriptions define the manufacturing process by which a detail item is manufactured or how an assembly or subassembly item is put together. It is a static set of data elements, i.e., it is independent of customer order or work order demands. It is based on a fixed quantity - usually one. Process descriptions are used in subsequent system modules to support actual manufacturing activity.

Why this module?

Computer-based manufacturing control systems have been in common existence for the last 20 years. Their greatest development activity has been in the last 10 years. Thousands of manufacturing enterprises have embarked and continue to embark on the path of developing computer-based manufacturing control systems. A result of the experience gained by most enterprises over these years has been the need to convert their existing manufacturing information systems and/or develop new information systems around a data base approach. This experience is being applied to the EVIG manufacturing control system. This module provides the basic EDP support required to develop a data base for the EVIG enterprise. A data base is defined as a non redundant collection of interrelated data items processable by one or more application modules.

Development and implementation of this module provides a general purpose data base for future application modules. Stated another way, as future application modules are added to the manufacturing control system they will build upon the foundation, or data base, establishing by the implementation of the basic records-I application module. This approach contrasts with the alternate approach of building a new data base for each new application. The result being that two or more independent data bases are established. Each data base will have common data elements. As time passes these common data elements will start to disagree in content value. As a net result the system user discards the system. Great effort is then spent in redoing the systems around a data base approach. Therefore this module is accepted as the beginning EDP module when an enterprise is building an integrated manufacturing control system.

Who are the users of this module?

Broadly viewed, every functional organization within the EVIC enterprise is a user of this module. This is so because, as stated earlier, this module is common to all future application modules. More specifically, the users responsible for actual entry and maintenance of the basic data exist in two groups. The first group is the department in the central engineering organization responsible for creating and maintaining bills of materials and establishing raw material "norms". The second group is the plant technolog department. Implementation of this module will probably place the greatest change of doing work on this latter organization.

Central engineering will be responsible for creating item descriptions and engineering product structures. The plant technolog department will be able to add additional data to these item descriptions. It must modify the product structure, where necessary, so that the actual fabrication and assembly of finished products is reflected in the manufacturing product structure. The module will support the creation of new item descriptions by the technolog department. This is required when no engineering item number (drawing number or bill of material number) exists. These new descriptions are sometimes referred to a synthetic number or dummy numbers. They have no engineering significance and in no way result in any changes to specifications of the end product.

Both user groups are supported in their maintenance of this module via the availability of module produced error list and audit lists. Error lists reflect the data base rejection of input data due to the detection of input criteria validity checks not being met. Audit lists serve two functions for the user. First, they provide a record of the information originally or currently included in the data base and, therefore, may be used in the reconstruction of certain records. Second, they serve as everyday working documents.

Module execution

From a user's point of view there are four major phases involved in the execution of this module. These are:

1. Source data preparation;
2. Source data input;

3. Data base maintenance;
4. Module user reports.

Phase 1. This phase is accomplished at the user's work place. Source data preparation is the creation of documents containing data base information. These documents must be filled out with strict discipline. It is expected that a users' guide or set of instructions will be available that will provide detailed information on how a specific source document is prepared. For the same purpose several hours of formal class-room instruction are also planned for the users. The user forwards the completed batch of source documents to the data input work area.

Phase 2. This phase is accomplished at either EVIC (EMR computer location) or at a site yet to be selected. This phase converts the source document data to computer readable data. Responsibility for this work phase has the organisation department.

Phase 3. This phase is accomplished at the site of the computer support centre. Transmitting source data between this phase and phase 2 and 4 is, most logically, the organisation department's responsibility.

Phase 4. This phase takes place at the user's work area. Reports generated by the computer in response to the source data are reviewed by the user to further check the validity of data put into the EVIC data base.

How often these phases are executed will vary with the degree of user commitment and computer hours available to EVIC. Phases 1, 2 and to a limited extent 4 should be run once every 24 hours. With adequate management direction, EVIC's capability to perform these phases every 24 hours is within the existing EVIC resources. Phase 3, and to a limited extent phase 4, should be run 3 times per week during the implementation phase of this module. Once the module reaches an operational level, execution of these phases should be minimum once per week, with the flexibility of performing these phases more often subject to work load conditions.

When is the module used?

Use of this module, from a user's point of view, may be viewed from two points: (a) initial implementation usage and (b) operational usage.

Initial implementation usage involves the creation and related maintenance of a start-up system. While the definition of a start-up system has not been fully established, it is currently defined as a system large enough to support a quarter's work plan. That is, all item descriptions and product structure definitions required to support a specified 3-months' worth of production. It is recommended that initial implementation be undertaken by a user task force group. This task force group would identify and prepare the necessary source documents. The number of labour weeks involved with this implementation activity has not been established. Initial implementation might continue beyond one quarter's worth of work. This would depend upon the desired rate of implementation, resources available and necessary computer time available to EVIC.

At some point in the use of the module, implementation is considered to be over and operational usage starts. Operational usage takes place as an integral part of the users' everyday work activity. Operational usage is essentially a maintenance activity. Changes and deletions to data put into the data base during the implementation period now take place. The additions of new data to the data base also take place during the operational usage period.

Use of this module, from a computer systems point of view, can only be established given a computer resource. This resource has not been established.

How does the module work?

To one familiar with data processing terminology, diagrams etc., the detail design portion of this documentation package should provide the general answer to this question. To one not familiar with this terminology, the following discussion is provided.

As mentioned earlier, three types of data base descriptions are required: (a) item descriptions; (b) product structure descriptions; and (c) process descriptions. The creation of these data base descriptions has two key elements of "how?". The first and most important "how?" is from the user's point of view. The second "how?" is from a computer data processing point of view. It is the first "how?" which we will now discuss.

Previous sections of this narrative have partially answered this question. Figures I and II illustrate the basic flow of the basic records-I module. The user prepares source input documents. These documents are converted to a computer readable form. The computer readable source data are then edited for proper alpha and numeric values. Logical relationships between some data element values are also checked. For example, if a data element is to be a 2-character numeric value and it is not, then the data will probably be rejected. If the 2-digit numeric value has a companion field that it should logically relate to, but does not, then the data will again probably be rejected. Error reports indicating the rejected data are created and distributed to the user. The user repeats the process, providing corrected input, until the data are accepted. After the data have been edited for correctness and are logically accepted, they are processed by the computer into the system data base.

When data are added to the data base an audit list is created. Audit lists are provided for the user. These lists indicate the stored form of the data base data. The user is required, for proper system operation, to review the audit lists. Review of the audit lists further insures that the data base contents and the user's data input objectives were satisfied.

B/R-I module requires the use of four source input documents. These documents, along with the source input document associated with the basic record-II module, represent the key input documents of the system. The system user has two source input documents to create and maintain item descriptions - one to create and maintain product structure descriptions and one to obtain basic retrievals. These input documents are illustrated in section B of this chapter.

Note that the source input document is used to create and maintain data base descriptions. The three basic data base descriptions are considered to have a life cycle. That is, they are created, changed and destroyed. Some data base descriptions may live a month, others may live years. The source input documents provide the basis by which descriptions are created, changed and destroyed.

In order to understand how this module works one should know the data elements required in the source document. A detailed list of the data elements associated with the source documents is given in appendices I and II.

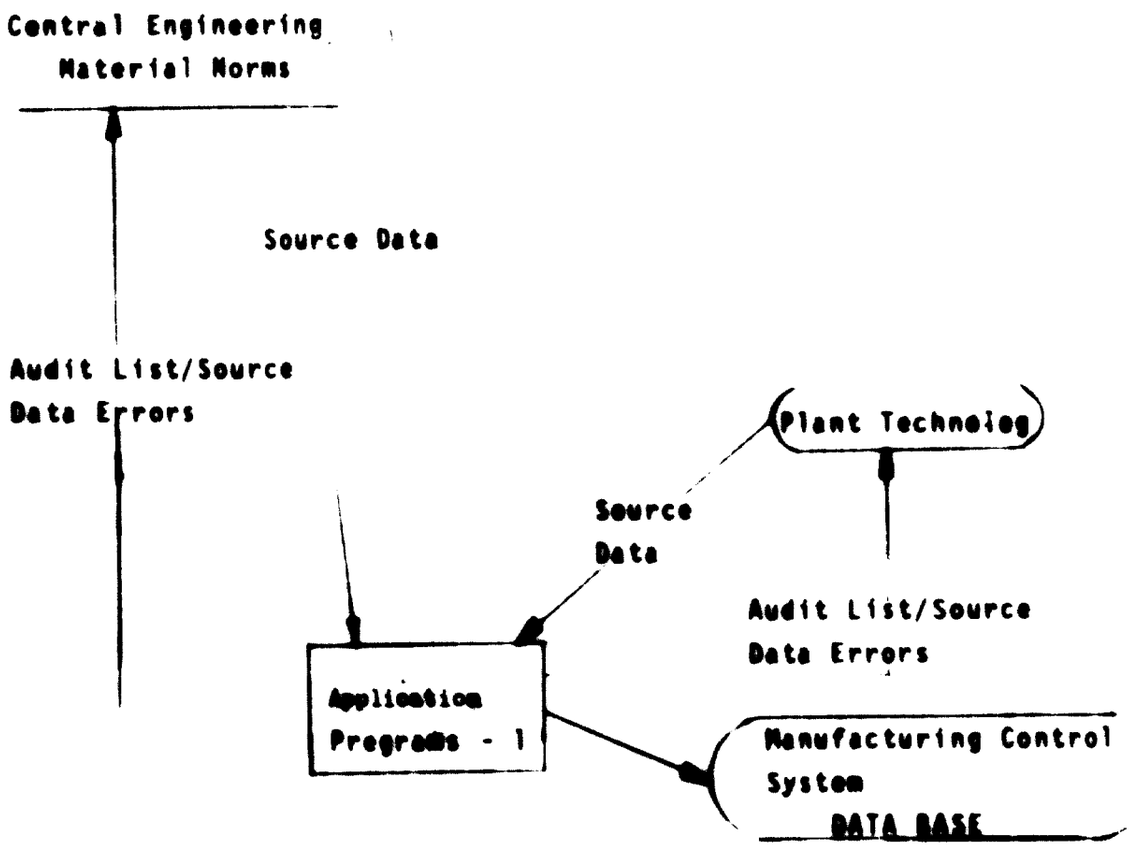


Figure I. Basic records-I module, Creation and maintenance submodule

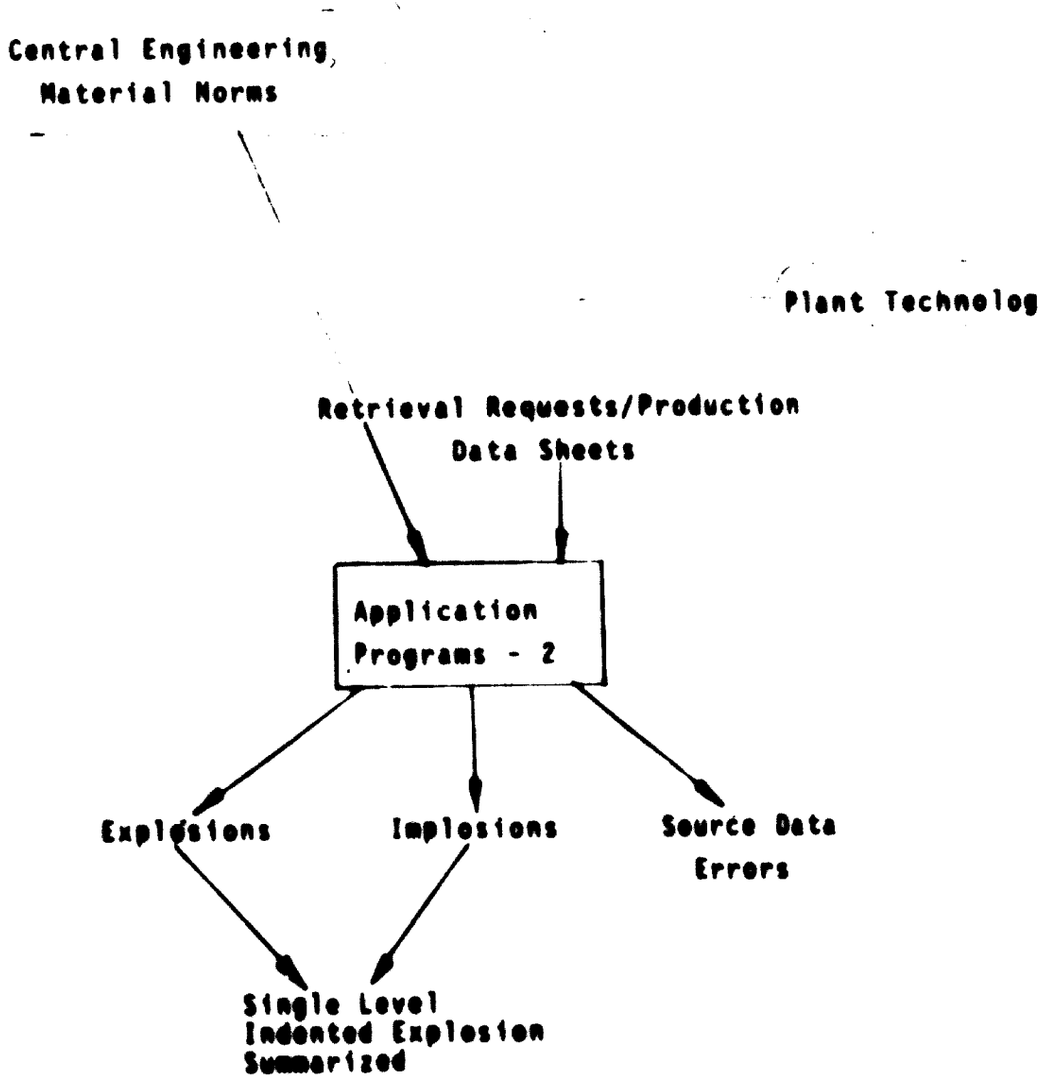


Figure II. Basic records-I module. Retrieval submodule

Inspection of the appendices will indicate several data elements which are new to EVIC. These data elements are key to the system and provide further answers to how this module works. These data elements or related topics are: (a) item number; (b) item type; and (c) product structure basics. Prior to discussing these data elements it is important to state that the design and development of a computer-based manufacturing control system is accomplished with the aid of basic application modules provided by manufacturers of computer hardware. These basic application modules require some fundamental adherance to rules. Several key rules deal with the item number and item type data elements.

Item number is a unique number attached to unique raw material, detail, subassembly and assembly items. It is also attached to purchased items. While this is not a new concept, the numbering of subassemblies presents the most difficult situation. In many instances drawings do not exist for manufactured subassemblies.

If the subassembly represents a discrete manufacturing process it will require an item number. The item number scheme recommended for EVIC is an 11-digit number made from three parts. It takes the following form: x-xxxxxxxx-xx.

x - item type
xxxxxxxx - 8-digit numeric number used in present drawing number system
xx - 2-digit variation number

Item type is a 1-digit numeric data element. It is logically attached to the part number or item number. It has four predefined values and one value which is defined by the user. These five values, for EVIC's use, are defined as follows:

1. Assembly and/or subassembly;
2. Detail item, made from raw material or a purchased piece;
3. Raw material;
4. Purchased item;
5. EVIC universal assembly.

Every item, as an integral part of its definition, must have an item type value attached.

The 8-digit numeric number portion of the 11-digit item number is the same 8-digit number scheme presently used by EVIC. Additional discussion regarding its use is not necessary.

The 2-digit variation number, in most cases initially would be assigned a value of 00 by central engineering. It intended use is associated with item type 5 assemblies. The intent of the variation number and item type 5 assemblies is to provide a simplified and more compact way to create and store on computer files those assemblies which have a wide degree of variability. Its use is optional. Item type 5 assemblies represent major assemblies which directly make up a finished motor. Figure III illustrates graphically some of its intended features. By establishing one universal product structure (5+A+00), several unique product structures may be created (5+A+01, 5+A+02, 5+A+03). In this illustration a saving of 50% in record creation and storage is realized. Additionally one item number is used, rather than three, to identify an assembly which has a common function.

The essential rules which apply to product structures are not logically new and are relatively few in number. Some of the key rules are as follows:

(a) Assemblies are made from assemblies, details, raw material and purchased parts;

(b) Detail items are made from raw material and purchased parts;

(c) Complex product structures are established by loading into the computer single level product structures (see source document);

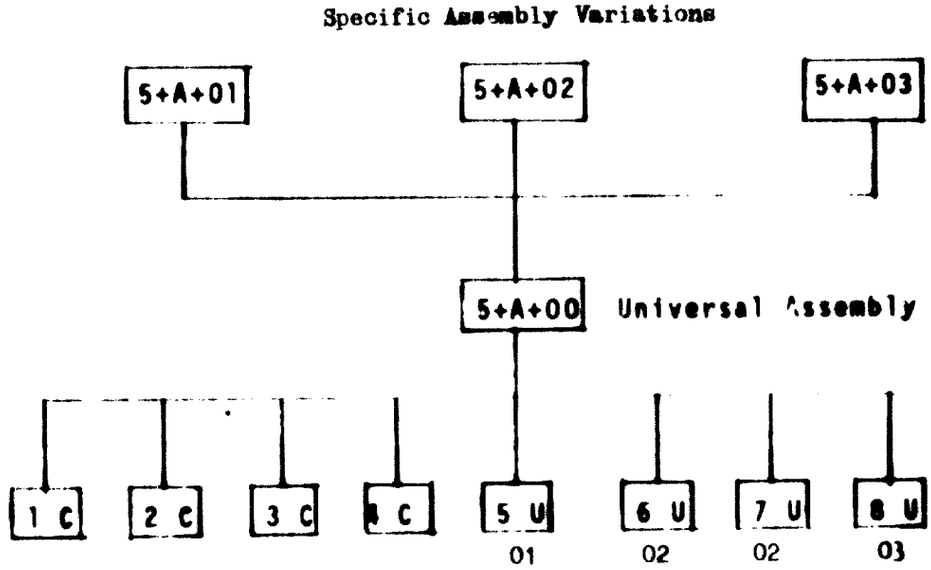
(d) No assembly can be made from assembly containing itself;

(e) A component item can exist only one time (no limit on quantity) per parent;

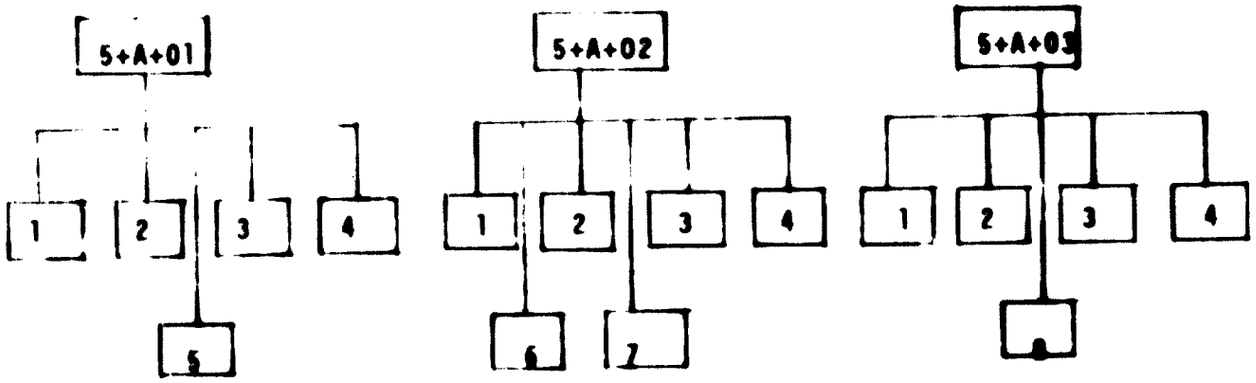
(f) A product structure is defined only one time, regardless of its usage frequency and structure location.

A significant custom feature is planned to support the product structure capabilities of the system. This feature allows the creation of one product structure which, when retrieved by engineering or manufacturing, will be presented in its engineering or manufacturing form. Figure IV illustrates this feature.

Additional information regarding how data base descriptions are made can be obtained by review of other sections of this documentation package.



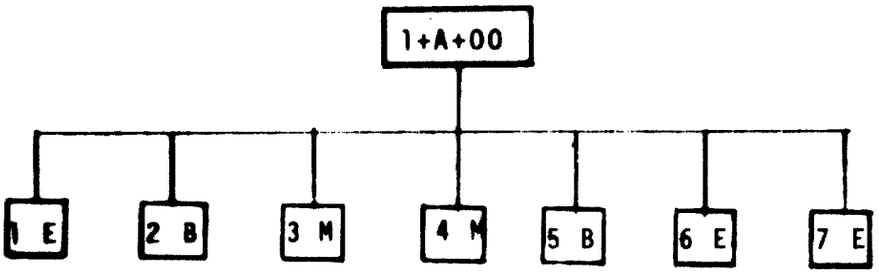
One universal product structure



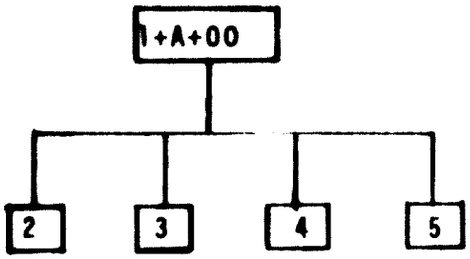
Three unique product structures

Legend: C = common item usage
U = unique item usage

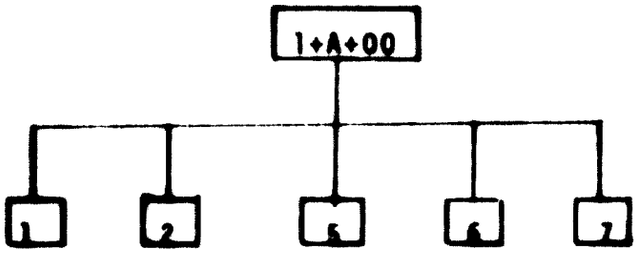
Figure III. Product structure. Variation number for universal assemblies



Combined Product Structure



Manufacturing Product Structure



Engineering Product Structure

Legend: Item number = 1+A+100; E = engineering; M = manufacturing; B = both.

Figure IV. Product structure. Engineering/manufacturing custom feature

The second "how?" - the computer data processing point of view - is now the subject of this narrative.

The module consists of three submodules identified as follows:

(a) Creation and maintenance;

(b) Retrieval;

(c) Reorganization.

The first two submodules are user oriented. The third submodule is directed to the organization department.

The creation and maintenance submodule permits both user groups to initially put information into the data base. In addition, this module supports the subsequent changes or additions to the initial data base input. Editing of input data is performed when new data and/or changes to the new data are made. If the input data do not pass edit criteria they are not accepted into the data base. The user is notified of this condition via source data error lists. Source data that pass the edit checks are added to the data base. To reflect this condition an audit list is produced indicating what the data base contains as a result of its source data input.

As data are being added and/or changed via the creation and maintenance submodule they may also be retrieved. The retrieval of data from the system data base takes place by two principal means. The first is via other application modules. These other application modules may change limited portions of the data base created by the basic records-I application module. These modules cannot, however, create or delete basic data base input. The second is via the second submodule of the basic records-I application module. This submodule is referred to as the retrieval submodule.

The retrieval submodule processes requests for explosions and implosions of complete electrical motors, major subassemblies, assemblies and detail items. The explosion retrieval breaks an assembly item number into its immediate components and may be continued to the raw material level. The implosion retrieval traces the direct and/or indirect usages of an item number on higher level assemblies.

Explosion and implosion retrievals are categorized into three types: (a) single level; (b) indented; and (c) summarized.

The single level explosion/implosion is the most fundamental retrieval. The explosion retrieval explodes an item number into its direct components. The single level implosion of an item number identifies the item number and its location.

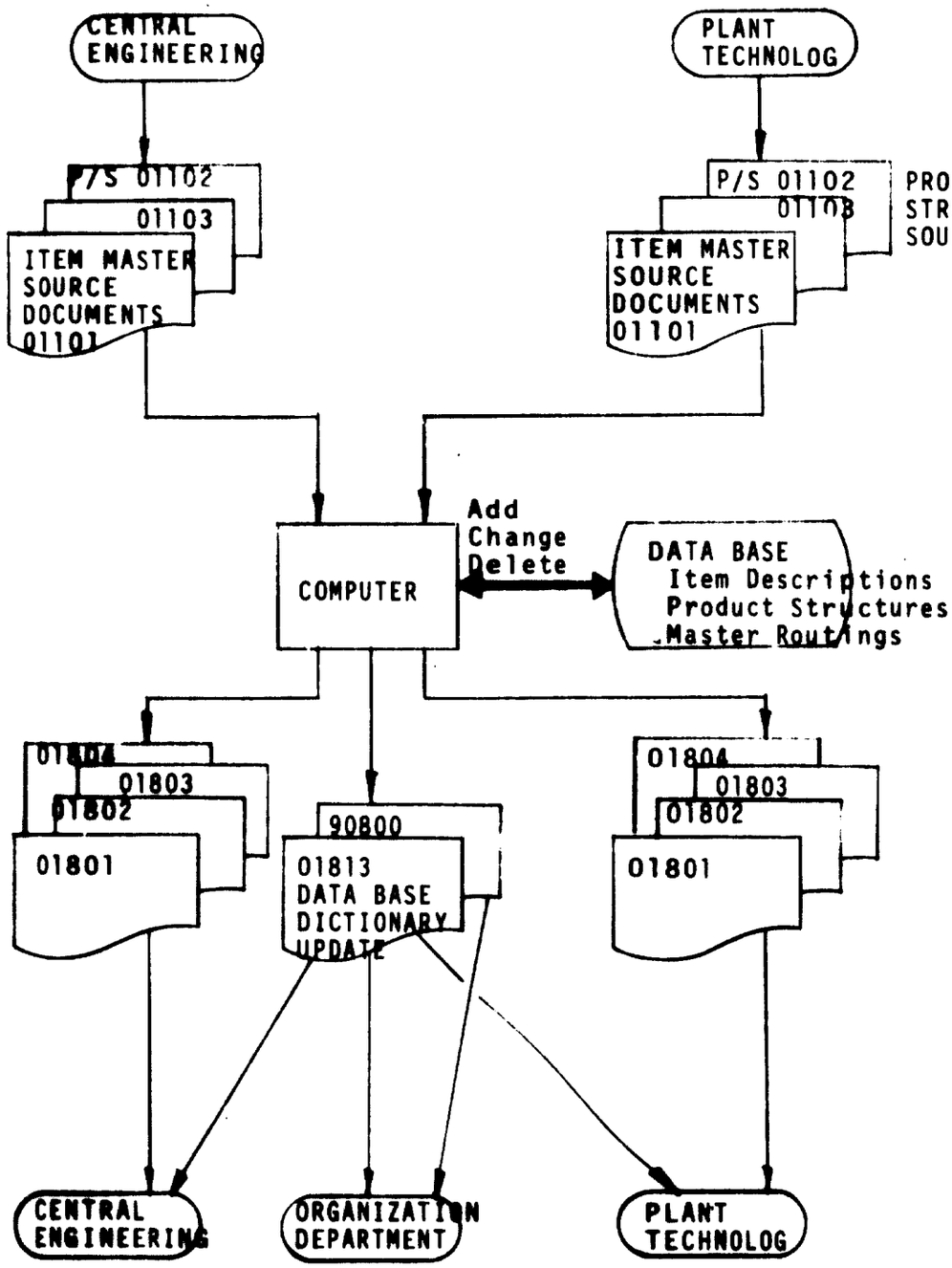
The indented explosion/implosion retrieves information regarding an item number from the top of the structure to the bottom (explosion) or from the bottom of the structure to the top (implosion). The term "indented" refers to the format of the output.

The summarized explosion retrieval summarizes the quantities of assemblies, details and raw materials used on a given item number. The summarized implosion is a multilevel processing technique that totals the direct and indirect usages of an item number on all high-level assemblies.

The primary input to this submodule will be retrieval request source document. Specification of a unique electrical motor, as identified by the production data sheet, may generate a complete explosion of the motor. Ten levels of explosion/implosion are planned for support of the system.

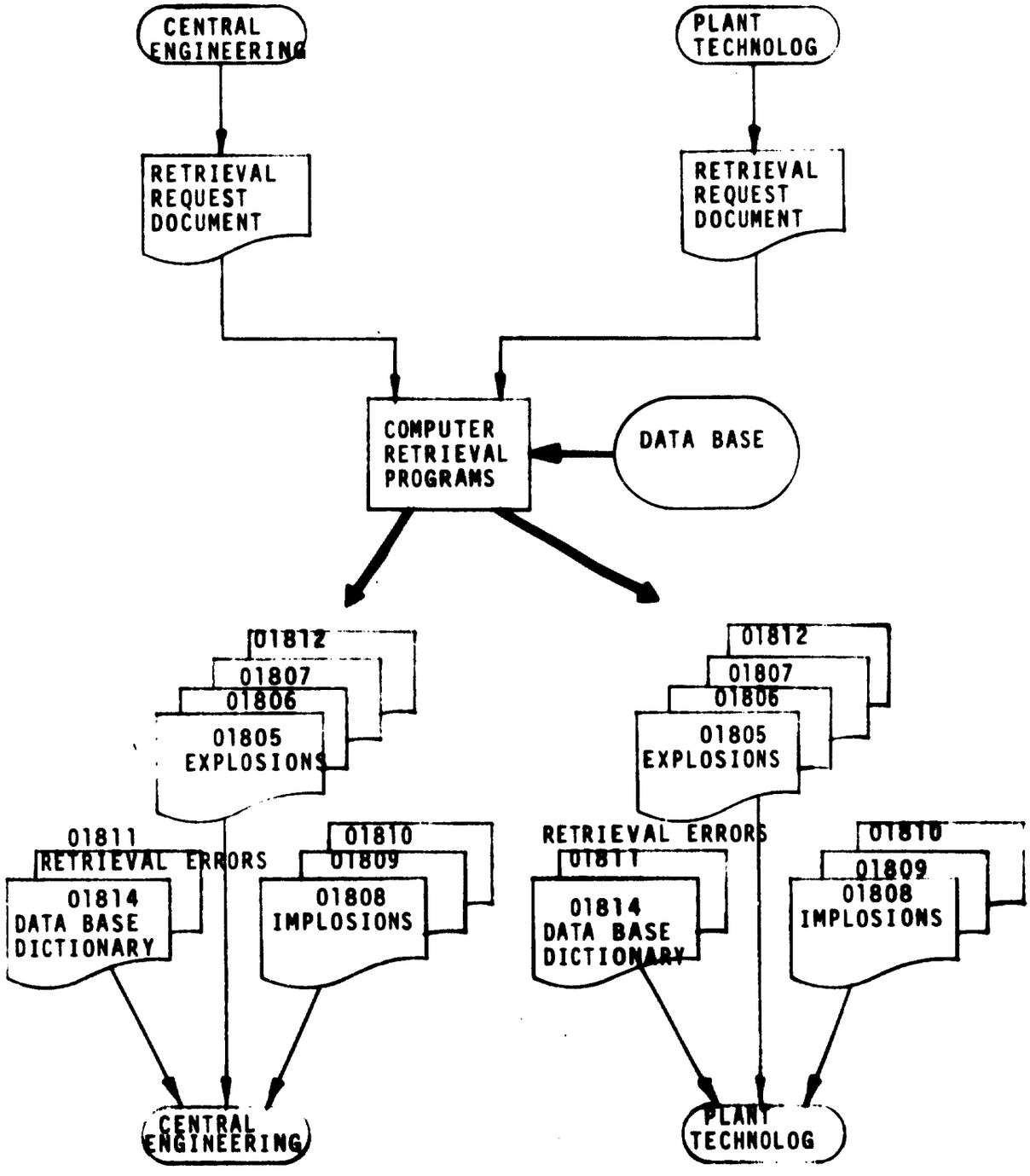
B. System flow charts

Data base creation and maintenance



01801 - Error list - Item master source documents
01802 - Error list - Product structure source document
01803 - Audit list - Item master
01804 - Audit list - Product structure
90800 - Error list - Unknown source data

Data base retrieval



C. Source input documents

001101	Item description	Item types 1, 2, 3, 4 and 5
01103	Item description	Item type 2
01105	Item description	Item type 3 and 4
01104	Retrieval requests	
01102	Product structure description	

(See appendices I and II.)

D. Report outputs

01801	Error listing. Item master source document
01802	Error listing. Product structure source document
01803	Item master audit list
01804	Product structure audit list
01805	Single level product structure
01806	Indented product structure
01807	Summarised item number usage
01808	Single level, where used
01809	Indented, where used
01810	Summarised, where used
01811	Error listing. Retrieval request source document
01812	Explosion retrieval. Single level file dump
01813	Item master dictionary update
01814	Data base dictionary
90800	Error listing. Bad control cards

Appendix 1

ITEM MASTER SOURCE DOCUMENT DATA ELEMENTS

1. Date data was prepared;
2. User department number - (xxxx);
3. Item type - (x);
4. Item number - (x-xxxxxxxx-xx);
5. Item variation number - (xx);
6. Current engineering level - (x);
7. Item description (20 characters)
8. Responsibility code - (xxx) (a number to identify the person or group responsible for the item master record, the product structure or the master routing);
9. Unit of measure - (xx);
10. Hungarian standard form - (xxxxx);
11. Quality standard number - (xxxxxxxx);
12. Hungarian standard quality - (xxxxx);
13. Raw material number - (xxxxxxxxxxx);
14. Raw material detail size - (xxxxx-xxxxx-xxxxx);
15. Quantity of raw material pieces per detail - (xxxxx);
16. Raw material unit of measure - (xx);
17. Raw material units per detail - (xxxxx,xxx);
18. Raw material weight - (xxxxx,xxx);
19. Raw material stocked size - (xxxxx-xxxxx-xxxxx);
20. Unit price - (xxxxxxx,xx);
21. Statistical number - (xxx);
22. Statistical factor - (xxxxxx).

Appendix II

PRODUCT STRUCTURE SOURCE DOCUMENTS DATA ELEMENTS

1. Date data was prepared;
2. User department number - (XXXX);
3. Parent item number - (X-XXXXXXXX-XX);
4. Component item number - (X-XXXXXXXX-XX);
5. Quantity of component required per unit of parent (XXXXX.XXX);
6. Unit of measure for component item - (XX);
7. Use code

   E - engineering

   M - manufacturing

   B - both

8. Component type

   C - common

   U - unique

9. Add/delete indicator - (plus/minus sign);
10. Variation number;
11. Component scrap factor - (.XX);
12. Operation sequence number - (XXX).

III. BASIC RECORDS-II MODULE[1]

A. Narrative

A fundamental concept in the design and implementation of the new HVIG system is to break the new system into modules and assign one team to each of the modules. The member of a team should combine operational experience in performing line functions with specialist knowledge in order to encourage interdepartmental and interdisciplinary thinking. Each team should acknowledge its share in the common responsibility for realising an efficient information system around a data base. The new HVIG information system must become an integral part of the organisation (Factory No. 1), and it is clear that the top management of the organisation must be involved in all phases of the system effort to be sure the new system will be effective.

Introduction to the basic records-II module

The basic records-II module represents the third part of the basic information elements of the integrated data base within HVIG's MRP manufacturing control system. The other two categories of basic elements are (a) item description and (b) product structure. These two modules of the basic information elements are supported by an IBM application. The IBM application consists of programs that are integrated but can also be used independently of each other. This modular structure will allow a step-by-step design and implementation of HVIG's manufacturing control system. The sequence of the implementation can be decided by HVIG's special requirements and should be approved by HVIG's management.

The IBM application package provides HVIG with programs that load, maintain and reorganise basic files. It is designed to organize and maintain a central information system, linking, thereby, product structure records and manufacturing process descriptions with the item master file. This approach differs from the manual or automatic information systems, the design of which strongly reflects the functional areas of the organisation (i.e. sections, departments). These systems frequently serve the data stored in the various departmental files that are wholly or partially duplicated. Information systems with such data files have serious drawbacks. Time is wasted on updating the overlapping files. The files are seldom synchronised. Information that

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[1] Systems analysts: Ferenc Harsányi, HVIG; Horst Klette, UNIDO; István Lovász, HVIG; János Sarlós, HVIG.

should flow from one department to another often does not arrive in complete form, moves slowly and, on arrival, is most likely out of date. The work of maintaining basic information files tends to be put off and often is never accomplished.

Fundamentals of the basic records-II module

Design of the basic records-II module supports data input from the manufacturing engineering department (plant technolog department). The basic records-II module strongly depends on the basic records-I module. The inter-relationship of these two modules is described below.

Assume that the user asked the system for a routing, for which the item number (drawing, part number) does not exist on the basic records-I file. The system would reject the request and would create an error report. On the other hand the system would only flag a request with the right item number but non-existing routing data. The plant technolog department is able to put into the data base basic information elements which will reflect on the user's output requirements. The specific input requirements (source data) and the error and output reports are described in a later section of this study. Examples of basic information elements established by the manufacturing engineering group include description and sequence of operation, cost centre, work centre, run time, set-up time, tool number and cost/limit. The basic data of the basic records-II module specify the logical sequence of operations during the manufacturing process of detail parts and of assembly. The plant technolog department will supply this information and is also responsible for maintaining the basic records-II module.

Error lists and audit lists are needed for maintaining the basic records of the module. Error lists show the input data that were rejected by the data base because the input criteria were not met. The wrong input data must be corrected by the technology department before they are accepted by the data base. Audit list give original and current information included in the data base. The audit lists are used for two purposes. First, for the reconstruction of certain records and secondly, as everyday working documents.

Execution of the basic records-II module

There are four major phases in the execution of this module: (a) source data preparation; (b) source data input; (c) data base maintenance; and (d) module user report.

The source data are prepared by EVIC's technology department. The source document contains data base information and must be carefully prepared because any incorrect information that gets on to the data base will create errors in the new EVIC information system. It is expected that a user manual will be prepared. This manual should describe precisely the steps to be followed in filling out the source document for the basic records-II module. The technology department should check its own work before it is forwarded to the data input area.

The source data input is performed by EVIC's keypunch department. The source data must be keypunched and verified according to the keypunch instruction manual. The instructions for a particular source document can be found under the source document number. After keypunching is finished the organisation department will send the card decks of input data to the SZUV computer centre and the keypunch department will return the source document to the technology department.

The data base maintenance is done by SZUV computer centre. All reports are sent to EVIC for the module user reports.

The module user report reviews the computer outputs with the source documents. The main objective of this work is to assure correct data base input. Ideally, this module should be run every day during the implementation period and once a week during the operational period.

Initial implementation period

During the initial implementation period a start-up system is created. In this period it has not yet been decided if the entire data base could be developed at once or broken down into parts. This decision will depend on how many data fields of the old system can be used in the new system. A system that supports a three-month production is considered the most functional.

It is recommended that the initial implementation be done by a technology department group. This group will decide on the method of work and identify and prepare the necessary source documents. The duration of the initial implementation period will depend on the amount of old system data that could be used, the desired rate of implementation and the availability of the resources and the computer time.

Operational usage period

Operational usage starts after the implementation of the B/R-II module is considered to be completed. Operational usage is an integral part of the technology department's everyday work activity. It is essentially a maintenance activity. Changes and deletions to data put on to the data base during the implementation period now take place. The additions of new data to the data base also take place during the operational usage period.

The function of the B/R-II module

The B/R-II module consists of three submodules: (a) creation and maintenance; (b) retrieval; and (c) reorganisation. The first two sub-modules are technology department oriented. The third one is organisation department oriented.

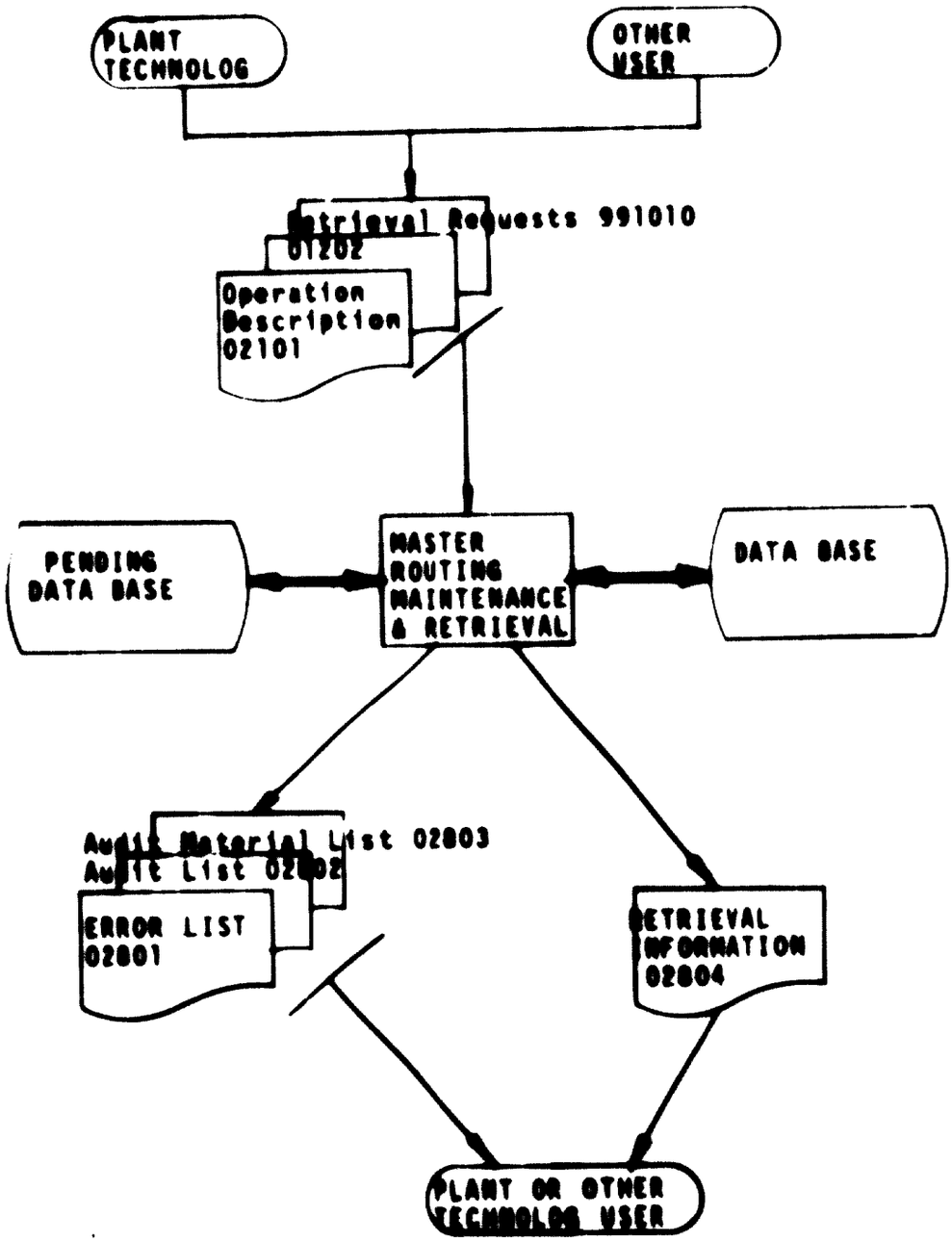
Under the first submodule program the initial information is put into the master routing and pending files. If errors have been discovered in the routings, the entire routing records are put into the pending file. The routings without errors are put into the master routing file. All maintenance work for the master routing and pending files is also done under this program. Although the data base is created under the basic records-I application module, certain portions of the data base can be started and maintained under this program.

The new input data and any changes to the input data must be edited. The data that do not meet the editing criteria are not accepted on to the master routing file and the data base. The technology department is advised of this by the source data error list. Data that have met the editing criteria are added to the system and signalled to the technology department on the audit list (report output list). The audit list gives the information about the contents of the master routing file.

Data can be retrieved through the retrieval module (routing retrieval). Routings are a type of retrieval used to prepare a sequential list of all the operations required to manufacture a detail part or put together an assembly. The list can be used as a reference document or, if extended by production factors, as a manufacturing work order.

B. System flow chart

Data base. Master routings creation/maintenance and retrieval



C. Source input documents

02101 Master routing operation detail

02102 Master routing operation description

99101 Retrieval request (see module 01)

D. Report outputs

02601 Error list. Source document 02101 and 02102

02602 Manufacturing routing. Audit version

02603 Parts and material list. Audit version

02604 Manufacturing routing. Retrieval version (see figure V)

02605 Parts and material list. Retrieval version (see figure VI)

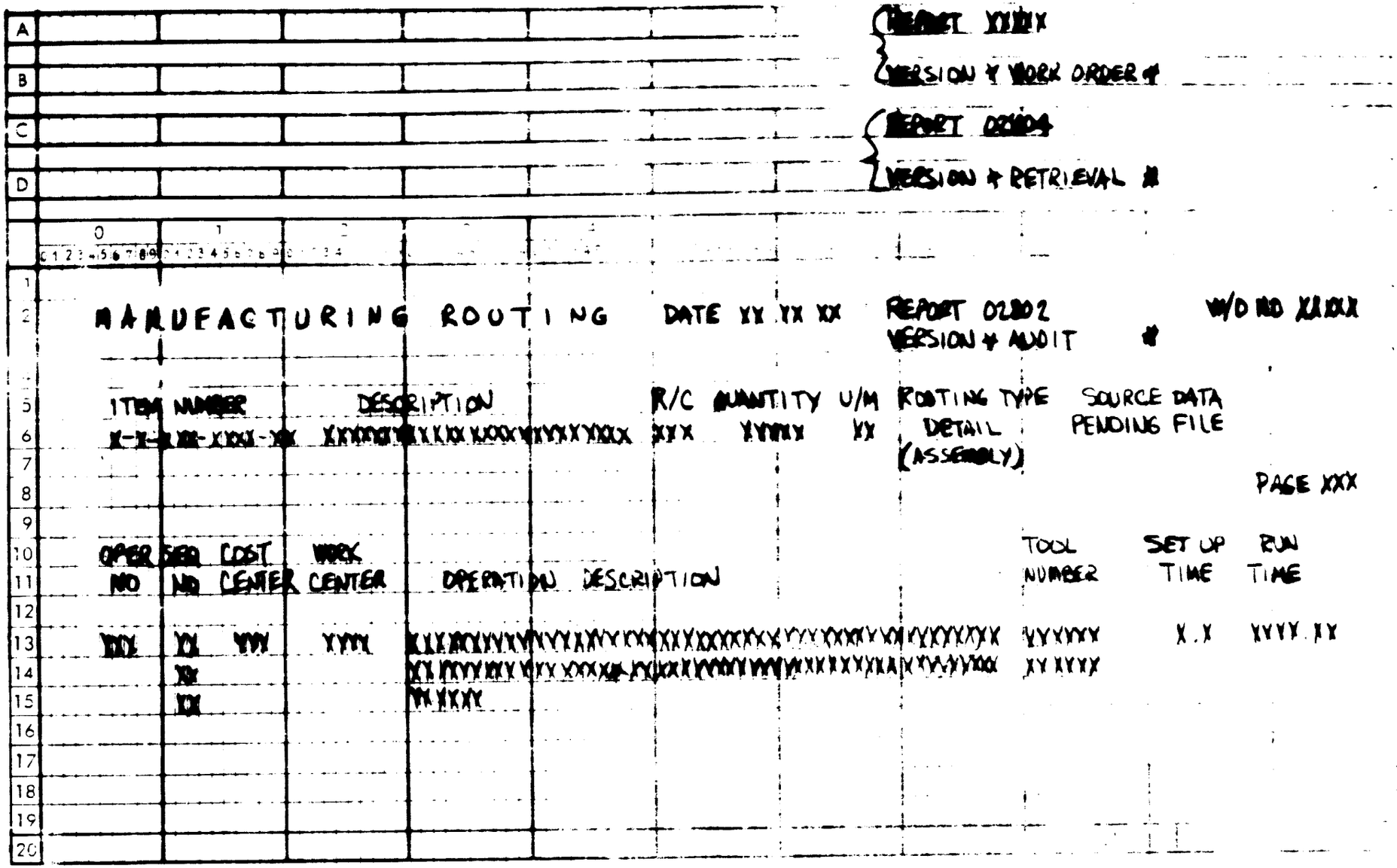


Figure V. Manufacturing routing. Retrieval.

REPORT XXXXX
VERSION * WORK ORDER *

REPORT 02806
VERSION * RETRIEVAL *

PARTS AND MATERIAL LIST DATE XX XX XX REPORT 02806 W/O NO XXXXX
VERSION * AUDIT *

ITEM NO X-X-XXX-XXX-XX QUANTITY XXXXX U/M XX

ITEM NO	DESCRIPTION	QUANTITY	U/M	OPER NO	WAREHOUSE NO	NO	* RAW MATERIAL * * * * OTHER	CUT SIZE	PIECES
X-XXX-XXX-XX	XXXXXXXXXXXXXXXXXX	XXXXX.XX	XX	XXX	XXXX	XXX	YES	XXXXX-XXXXX-XXXXX	XXXXX
X-XXX-XXX-XX	XXXXXXXXXXXXXXXXXX	XXXXX.XX	XX	XXX	XXXX		NO	XXXXX-XXXXX-XXXXX	XXXXX

Figure VI. Parts and material list. Retrieval

IV. COMMON DATA ENTRY MODULE 03[4/]

A. Narrative

The common data entry module provides a singular data processing approach to converting all user source data into computer readable form. This module is highly data processing oriented. As such it does not require indepth understanding by the user of the EVIG/UNIDO system. This is opposed to some modules which are considered user oriented. For example, the basic records-I and -II modules are highly dependent upon user's understanding and involvement. The organization department is responsible for the successful performance of this module.

Operation of this module is planned to ultimately run at EVIG's data processing centre. The capability of operating this module and module 04 (common print) at EVIG would permit the EVIG management to work on a daily basis with the EVIG data base. This capability is a must to successful run of a modern integrated manufacturing control system. The initial version of the EVIG/UNIDO common data entry module is based on card media for entering data into the data base. This media may be changed at a later date to a more sophisticated and faster means without requiring serious rework to the system data base.

This module provides three major data processing services for the EVIG/UNIDO system. They are:

1. One set of computer programs to process all user source data;
2. One computer process run to edit all user source data;
3. Creation of edited transactions for subsequent use by other systems modules.

These data processing services are illustrated in the system flow chart in section B of this chapter.

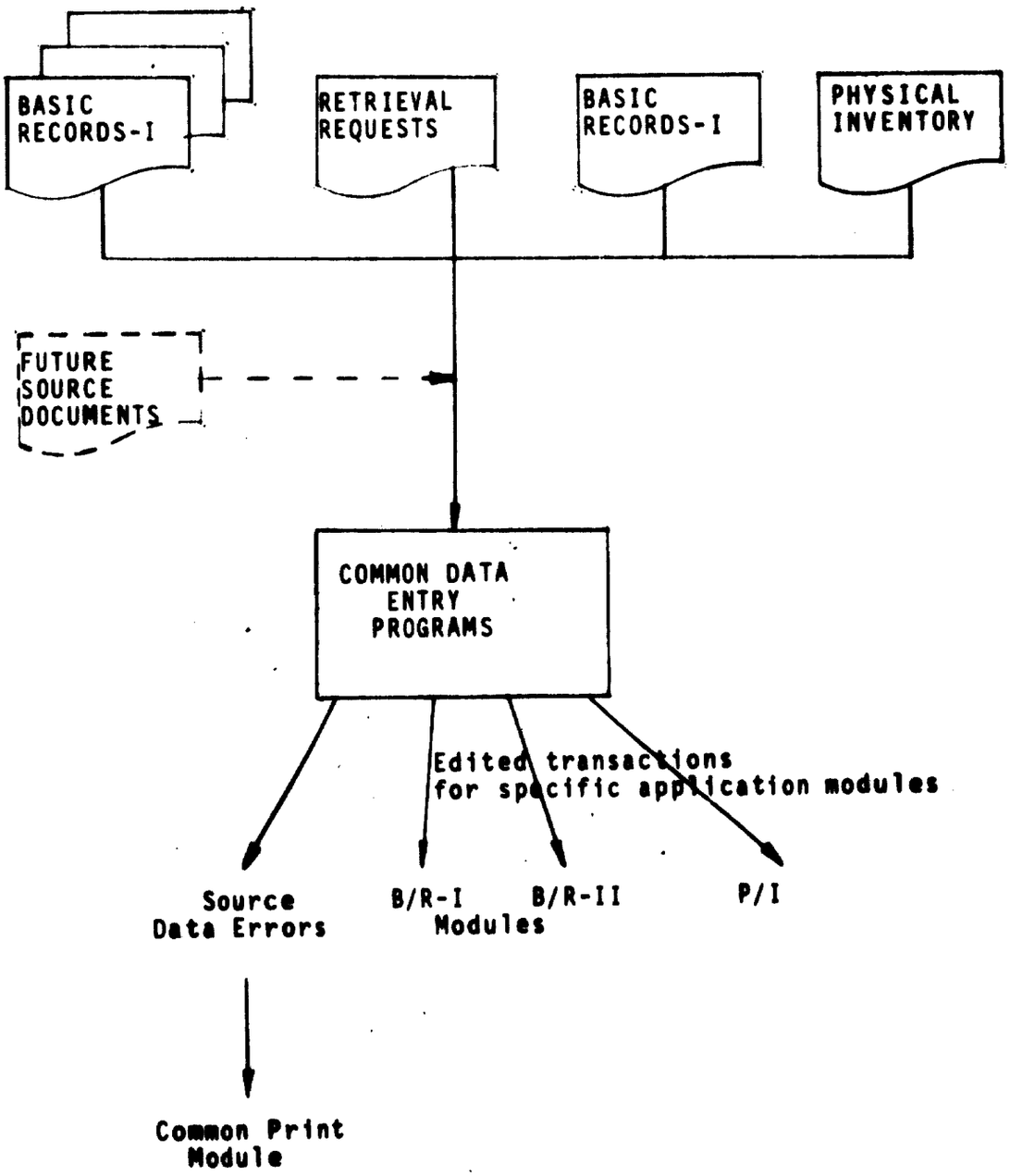
For source input documents see modules 01, 02 and 11.

The common data entry module provides no report outputs. Tape files and possibly several disk files are the only output of this module.

4/ Systems analysts: Ferenc Harsányi, EVIG; Horst Klette, UNIDO; Istvánné Laczkó, EVIG; Péter Lukáts, EVIG; Dan L. Morris, UNIDO; István Noszkó, EVIG; Tibor Tordai, EVIG; Balázsné Tóth, EVIG; Sándor Solti, EVIG; János Sarlós, EVIG.

B. System flow chart

Common data entry module



V. COMMON PRINT MODULE 04[5/]

A. Narrative

The common print module provides a singular data processing approach to printing all computer reports that the EVIG/UNIDO system generates. Operation of this module is planned to eventually run at EVIG's own data processing centre.

The operation of this module and the common data entry module, at EVIG, will permit the management of EVIG to establish and maintain the system data base in an effective manner. This means that the users of the system will be permitted to create and maintain basic data base descriptions and be informed of the effectiveness of their activities on a 24 hour-daily basis.

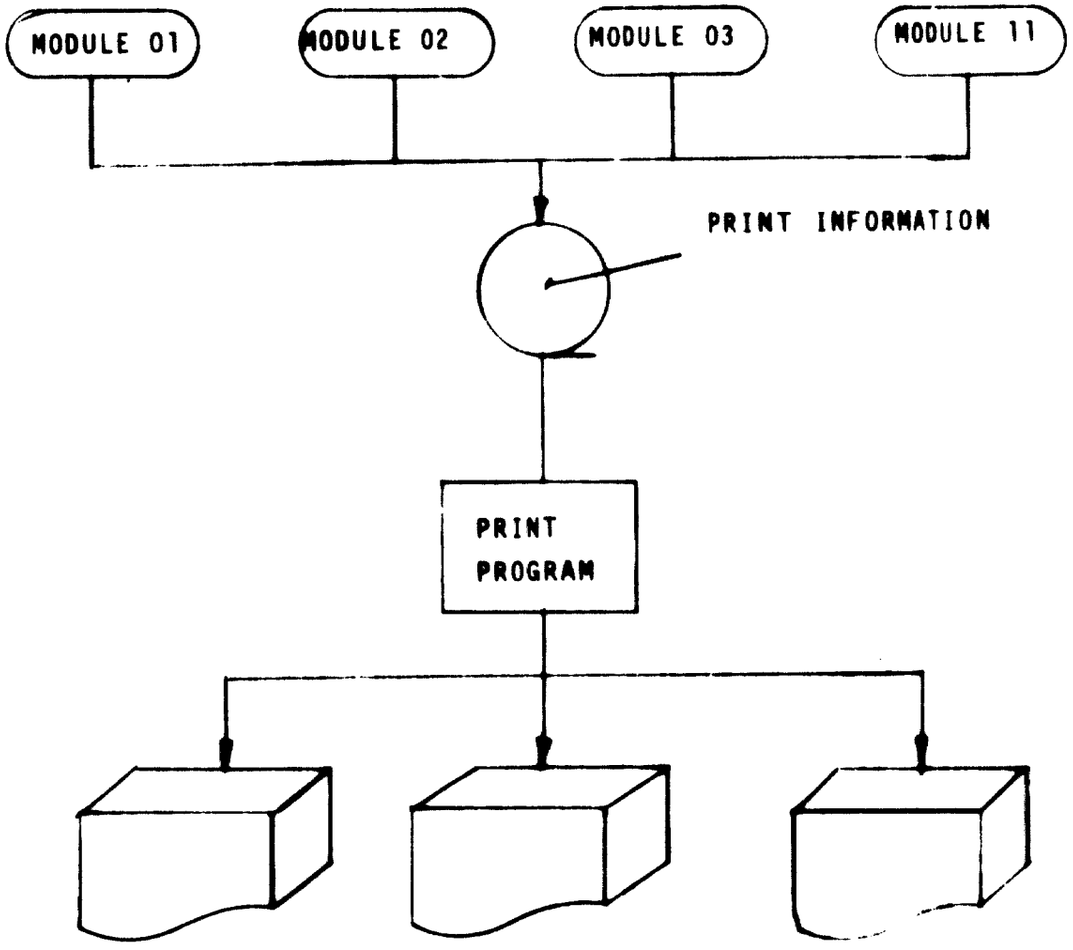
This module is highly data processing oriented. As such it requires little or no indepth understanding by the users of the system. The key to its successful operation is with the organization department.

The reader is directed to other general design specifications to review the computer generated reports produced by this module.

5/ Systems analysts: Istvánné Juhász, EVIG; Péter Lukáts, EVIG; Dan L. Morris, UNIDO; Gabriella Reményi, EVIG.

B. System flow chart

Common print module



REPORTS MODULE 01

. ITEM DESCRIPTIONS
. BILLS OF MATERIAL

REPORTS MODULE 02

. MASTER ROUTINGS

REPORTS MODULE 11

. PHYSICAL INVENTORY

VI. PHYSICAL INVENTORY MODULE 11[6/]

A. Narrative

The physical inventory subsystem was designed and executed within the manufacturing control system of EVIG/UNIDO. This documentation gives summarized description of this module. The documentation answers fundamental questions necessary for the correct understanding of this subsystem. These questions are:

What is the physical inventory module?
Who are the users of this module?
Why this module?
When is the module used?
Module execution.
How does the module work?

What is the physical inventory module?

The physical inventory module maintains a current balance of that inventory physically available in the EVIG warehouses. The physical inventory balance is determined by the warehouse receipts and issues. Previously, receipts and issues of material were done with the use of several documents. These documents were of different form but contained the same data. The new system's issues and receipts are recorded on the new warehouse movements sheet. This new document eliminates the many different forms used previously. It identifies issues, receipts and adjustments for each warehouse. Furthermore, movement activity is identified by categories. A new task of the warehouse worker is the preparation and the forwarding of this new source document to the information department.

A warehouse characteristic of Factory No. 1 is that part of its physical inventory is stored by the EVIG central warehouse. Stated another way, the central warehouse stores the same item for more than one factory. Previously, the central warehouse did not record issues and receipts by factory. Therefore no balance of physical inventory for Factory No. 1 was available. The new system requires physical balance by factory number. All issues and receipts activity are charged against the proper plant.

6/ Systems analysts: Dan L. Morris, UNIDO; László Ság, EVIG; Tibor Tordai, EVIG.

Who are the users of this module?

The main user of this module is the warehouse. The warehouse is responsible for the quality of systems data and making sure that the physical quantity is the same as the data base quantity. Only the warehouse is able to provide this service.

Indirect users of this module include material management, manufacturing control and accounting.

Why this module?

A physical inventory balance is a mandatory requirement in an integrated manufacturing control system. The physical inventory module provides this information; it provides timely reporting of physical inventory movements.

When is this module used?

The source documents are filled in when there is a change in the physical inventory. This change happens when items are received or issued. Movement of inventory is categorised and described by a transaction code. The frequency of inventory changes determines how often the warehouse worker has to forward the source documents. Forwarding of input data has to take place at least once a day.

How does this module work?

There are several warehouses in Factory No. 1, each operating in separate locations. In these warehouses there could be stored common as well as different items. This module identifies the fact and maintains unique balances by location. The punched cards, prepared on the base of source documents coming from the warehouse, are processed by the common data entry module that enters the input cards on magnetic tape and edits the source data.

For each item number there may be one or more inventory quantity values. Quantity values for each item are established and maintained for each unique location and factory that "owns" the item. It is mandatory that inventory requirements for each plant be maintained. When there is a change in the physical inventory balance of a warehouse a proper quantity adjustment authorized by the factory is made. In principle the real physical inventory

should conform with the inventory value recorded by the computer. In practice, however, differences will occur. Therefore, when an inventory record has a zero or a negative quantity balance, an audit list should be prepared. This audit list requires a physical audit. The preparation of output lists is made by the aid of a common print routine.

Execution of the module

From the user's point of view, execution of this module takes place in 4 phases. These are:

1. Source data preparation;
2. Source data input;
3. Data base maintenance;
4. User report distribution and use.

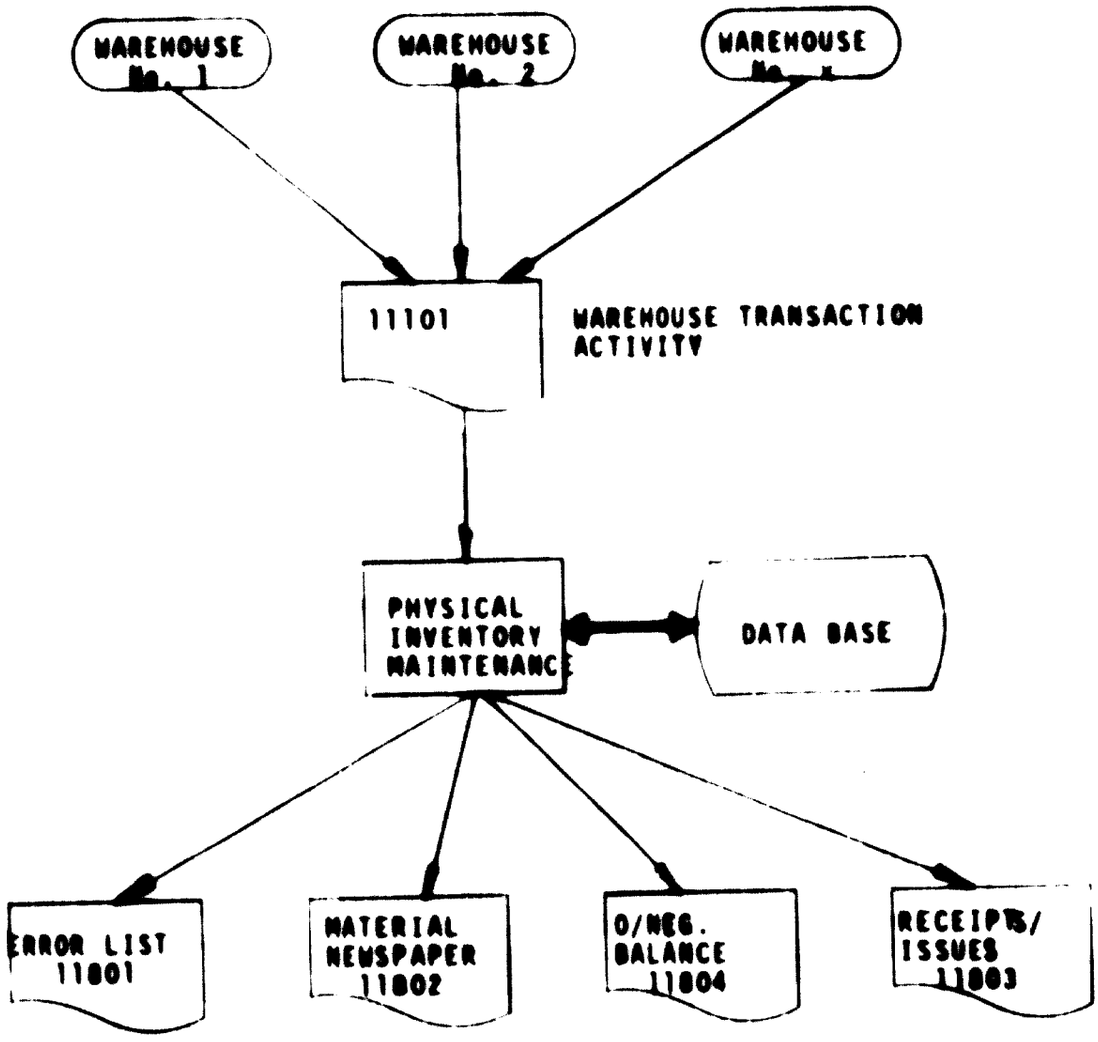
The first phase is completed at user's working area, i.e. in the warehouse. The preparation of source data is the creation of documents containing physical inventory movement data. The warehouse enters data on the source documents at the time that the actual inventory movement takes place.

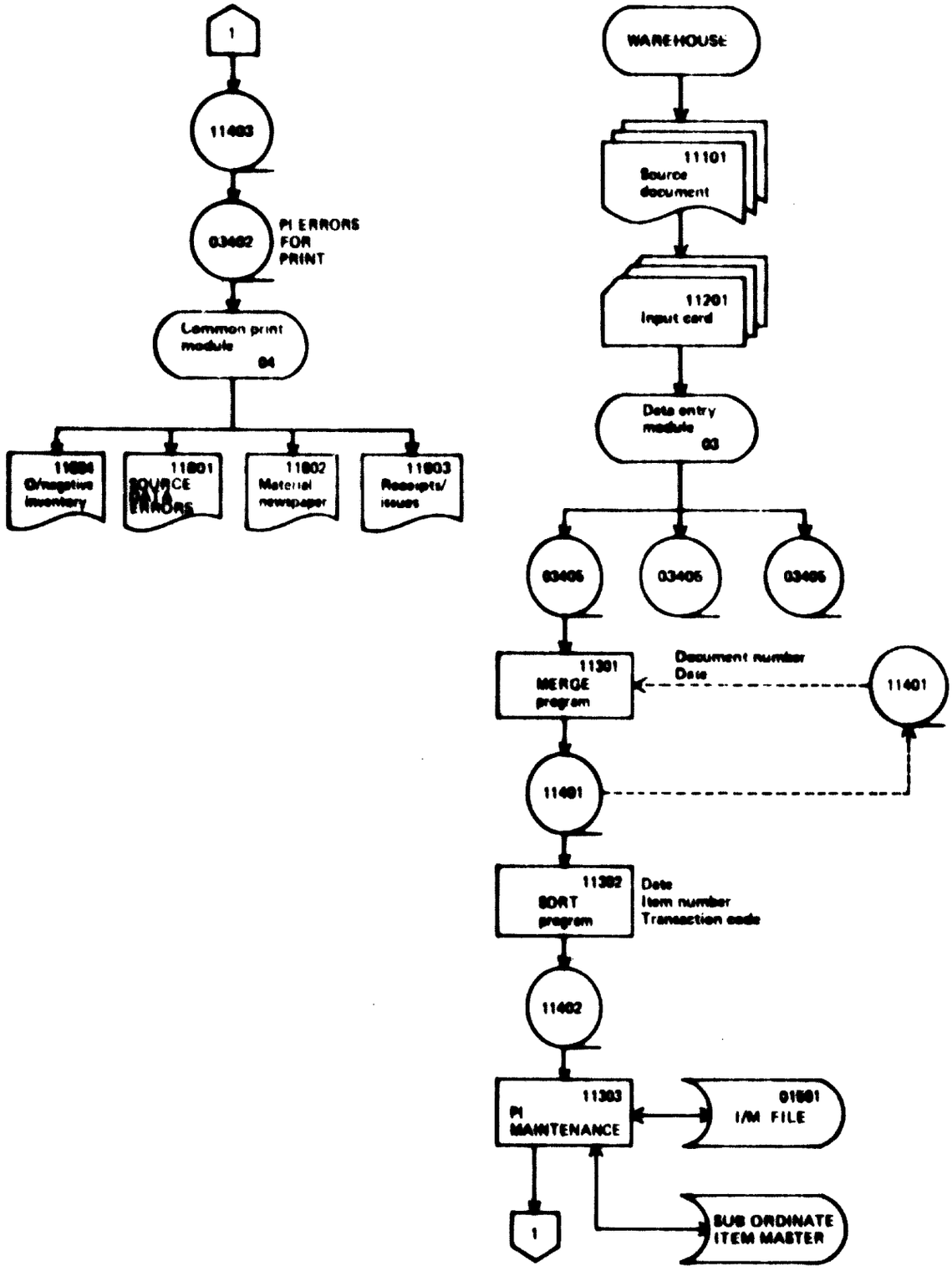
In the second phase the source document data are recorded on punched cards at the data input area.

In the third phase, updating of the physical inventory balances, i.e. the processing of quantitative data to determine the new inventory position, is completed.

The activity of the fourth phase is the comparison of computer output reports with the source documents created by the user.

B. System flow charts




1
11403
03402
PI ERRORS FOR PRINT
Common print module 04
11804 G/negative inventory
11801 SOURCE DATA ERRORS
11802 Material newspaper
11803 Receipts/ issues
WAREHOUSE
11101 Source document
11201 Input card
Data entry module 03
03405
03405
03405
11301 MERGE program
Document number Date
11401
11481
11302 SORT program
Date Item number Transaction code
11402
11303 PI MAINTENANCE
01501 I/M FILE
1
SUB ORDINATE ITEM MASTER

C. Source input document

Design of the physical inventory source document (see figures VII and VIII) considers demands of both the warehouse user and the computer-based manufacturing information system. This design simplifies the users' work activities and improves the data processing flow. The source document is designed as an integral part of the EVIG data base maintenance objectives. It contains only the data elements required to maintain accurate physical inventories. Sufficient data are created to provide interface links with other system modules.

A key data element in the source document is the transaction code. Item number description is found in the B/R-I documentation set. For the quantitative data, five integer positions and three decimal fraction positions are reserved. A 2-digit unit of measure is required to ensure proper quantity recording. The order number is used to identify the issuing or receiving authority. These numbers have been generated in the past by the material supply department and central sales department. Responsible for the completion of the source document is the warehouse keeper.

Raktári mozgást nyilvántartó bizonylat 41104

Control card

Bizonylat szám	Kitöltés			Sorok száma	Összes old. száma	Old. ser.	Raktár száma
	év	hó	nap				

Line number | Trans. code | Item number | Quantity | U/m | Order number

Sor-szám	Művelet kód	Cikkszám	Mennyiség	Mért egys.	Rendelési vagy munkaszám
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
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29					
30					

Figure VII. Physical inventory. Source document.

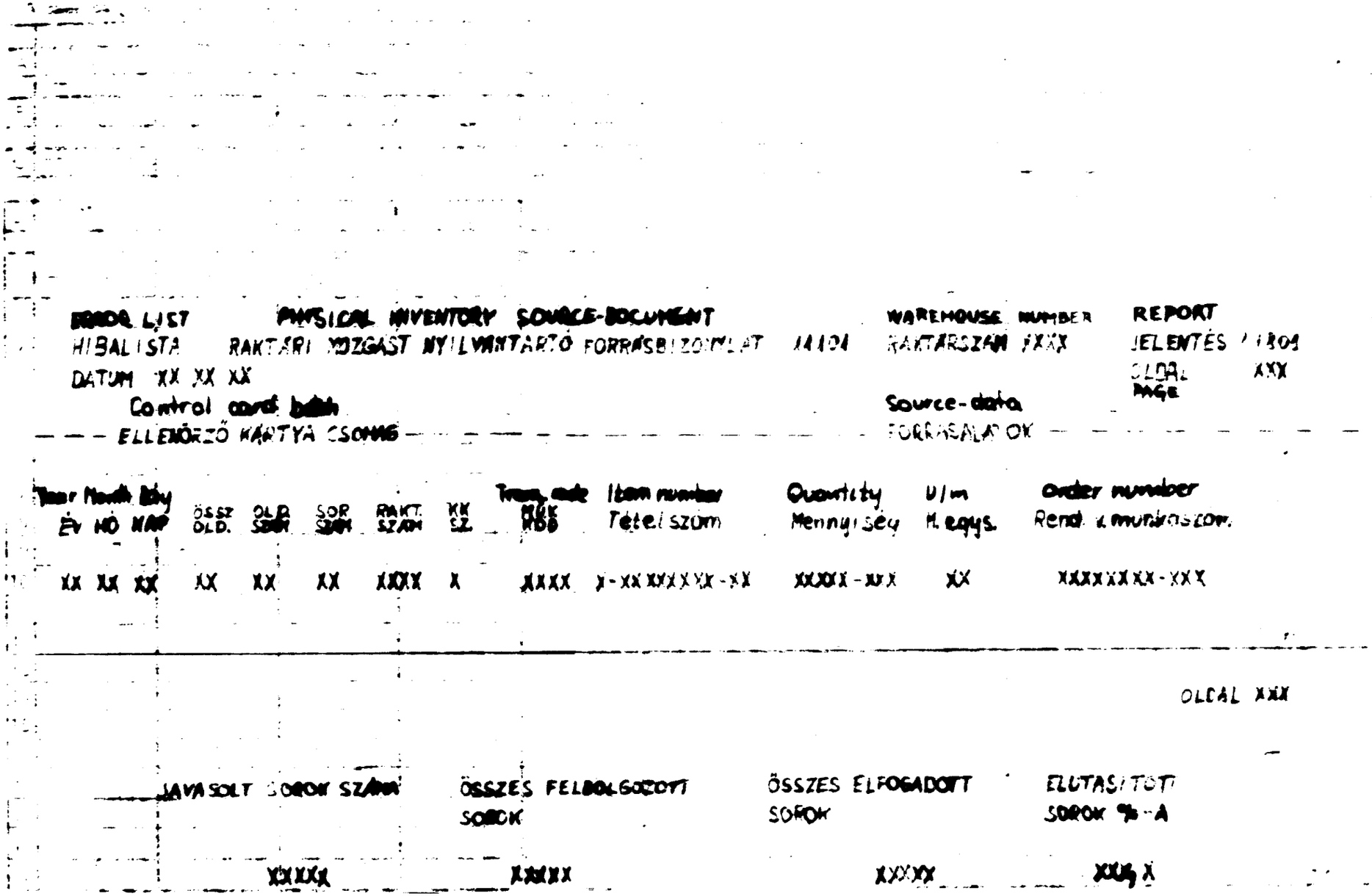


Figure VIII. Error list. Physical inventory source document

D. Report outputs

11801	Error list (see figure VIII)
11802	Material newspaper (see figure IX)
11803	Receipts/issues (see figure X)
11804	0/negative balances (see figure XI)

The identification of output reports is determined on the basis of user's requirements and proper inventory management. The following output reports have been prepared:

(a) Material newspaper;
(b) Receipts/issues;
(c) 0/negative inventory balance.

Material newspaper report contains a list of items received from suppliers by the factory warehouses. Its purpose is to provide users, i.e. manufacturing, material supply etc., with up-to-date receipt information.

Receipts/issues report contains a daily list of items and their quantities, received, issued and adjusted for each different factory warehouse. The direction of movement, i.e. in or out, is shown by the transaction code. The purpose of the report is (a) to provide an audit list for the warehouse keeper and (b) to provide current data to production control.

As previously mentioned, the inventory balance maintained by the computer is not always in agreement with the actual physical inventory balance. Therefore, an audit list is needed to identify those items which are reduced to zero or to negative balance. A physical check-up provides the control of the percentage level of inventory errors.

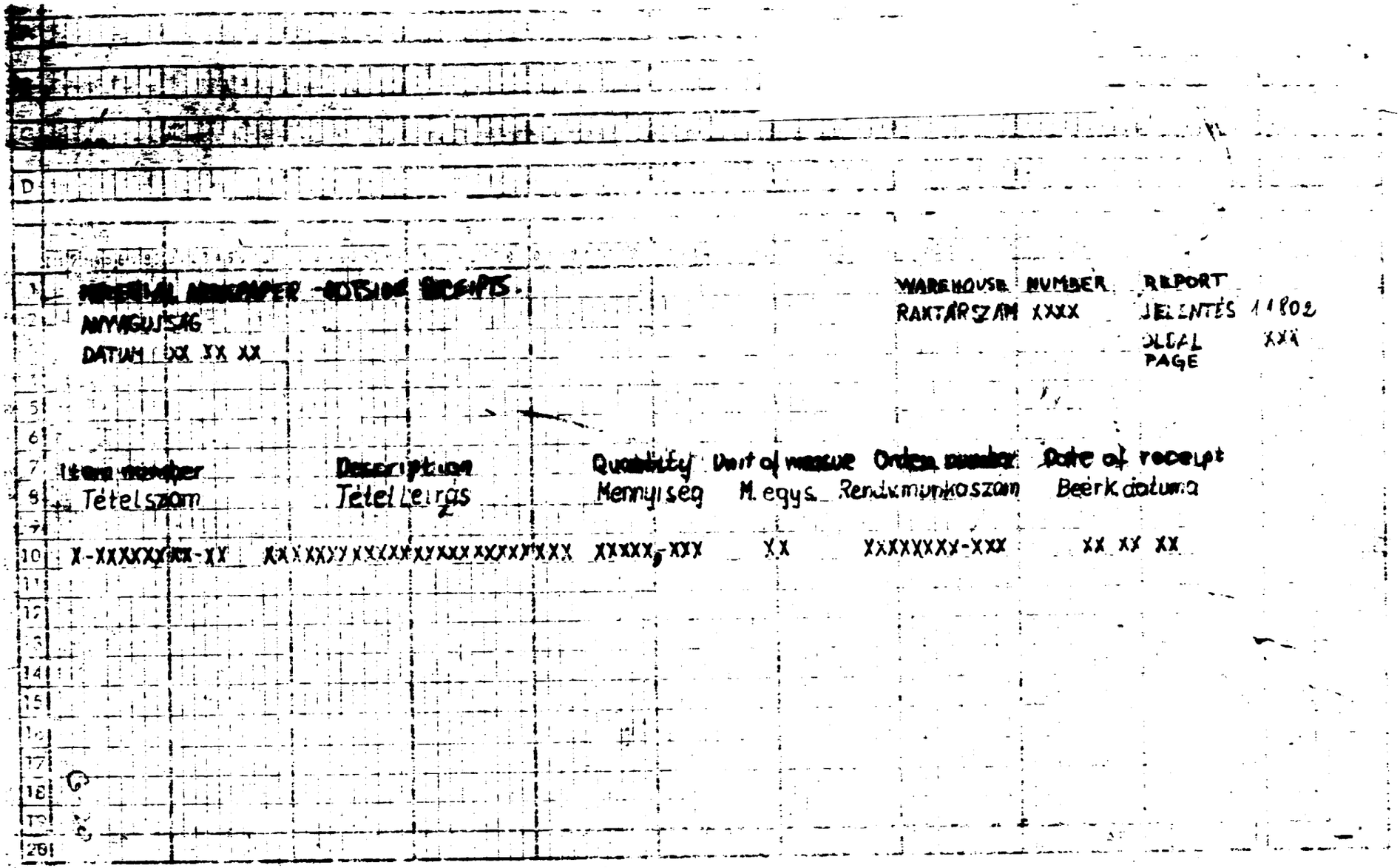


Figure IX. Material newspaper. Outside receipts

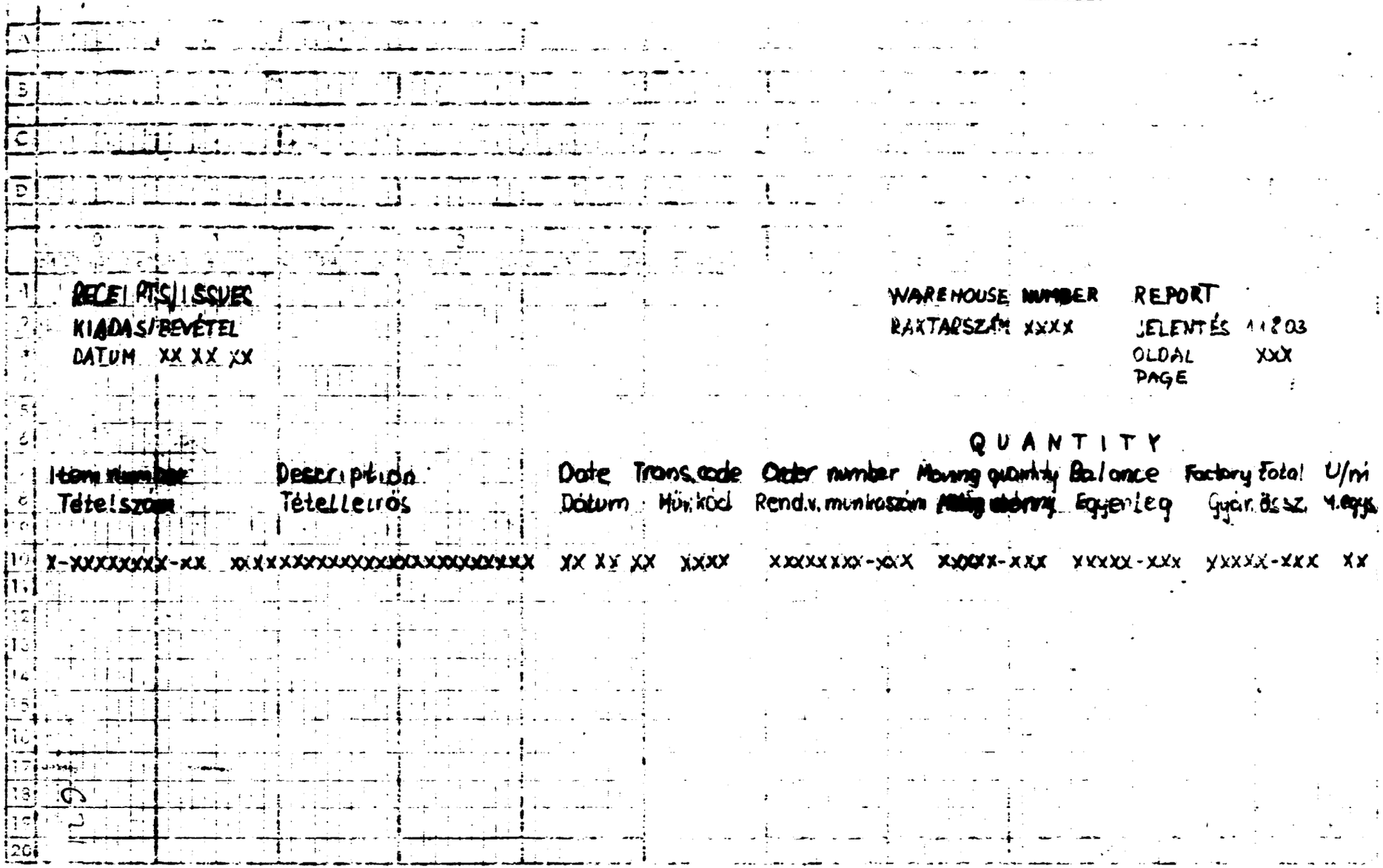


Figure X. Receipts/issues

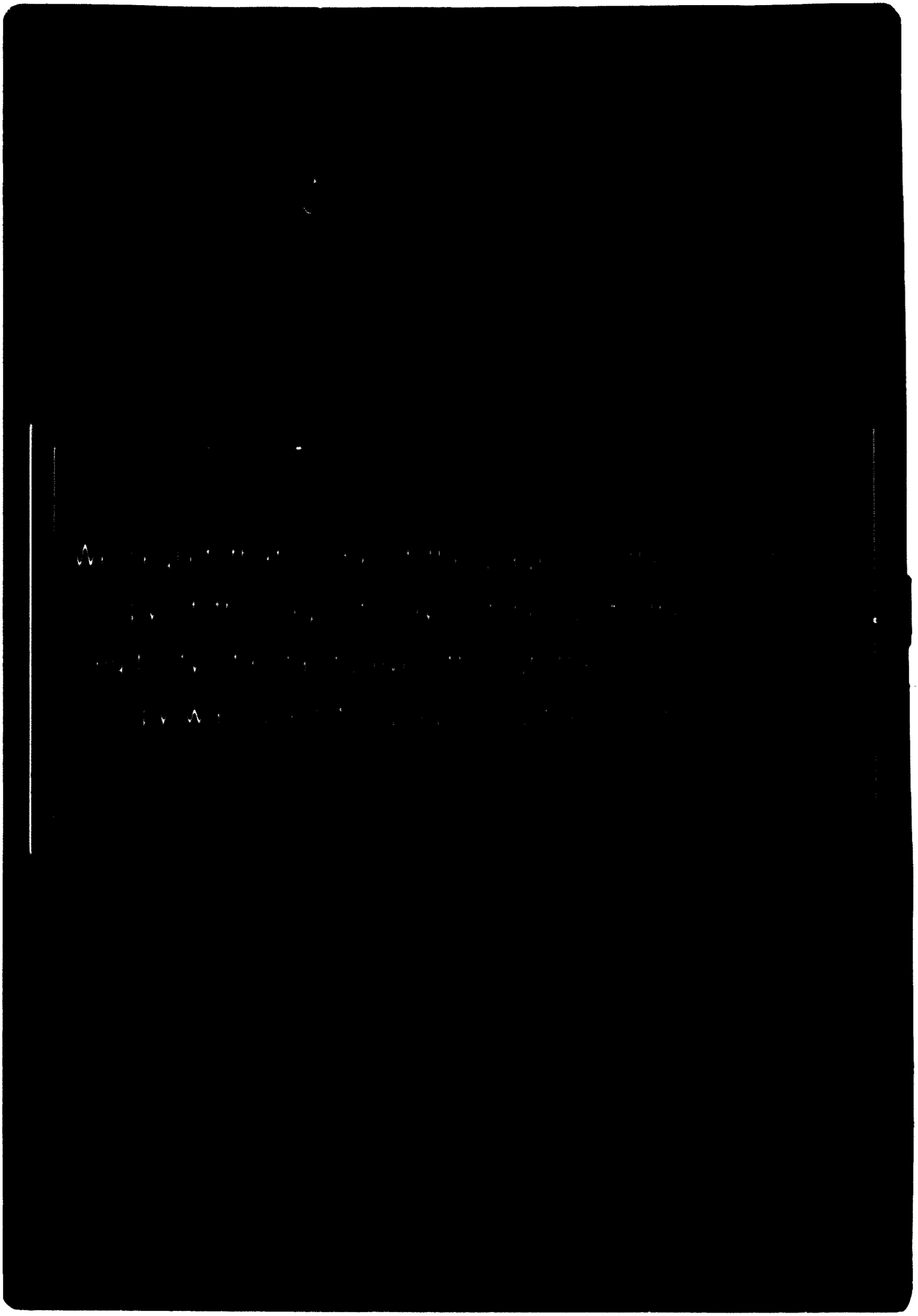
O/NEGATIVE INVENTORY
NULLA/NEGATIV KÉSZLET
DATUM XX VX XX
DATE

WAREHOUSE NUMBER
RAKTÁRSZÁM XXXX

REPORT
JELENTÉS 41204
OLDAL XXX
PAGE

Item number Tételszám	Decription Tételleírás	Quantity Mennyiség	Unit of measure M. egys.
X-XXXXXXXX-XX	XXXXXXXXXXXXXXXXXXXXXXXX	XXXX-XXX	XX

Figure XI. O/negative inventory



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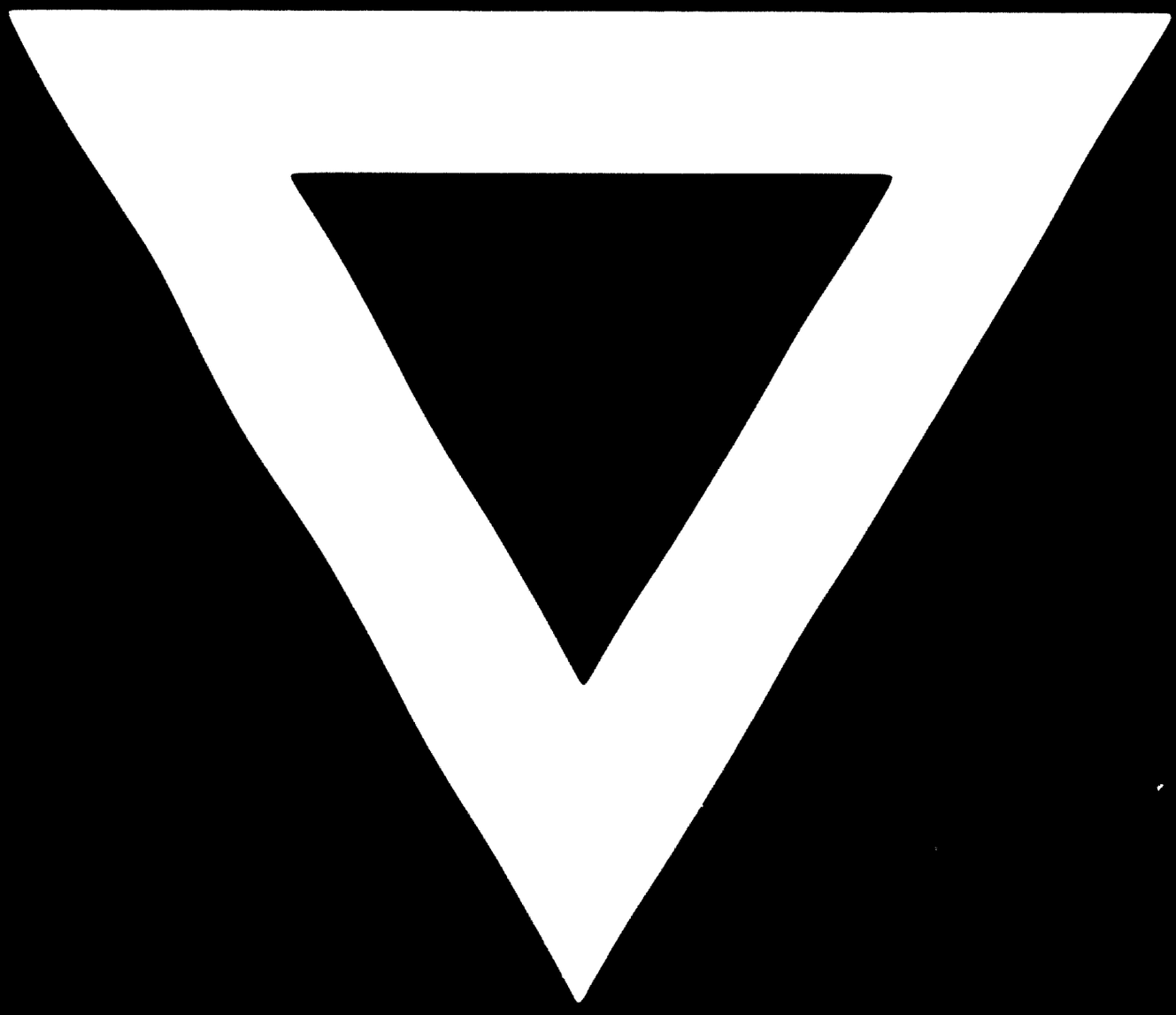

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