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Beirut, Lebanon, 10 - 26 August 1970

SYSTEMS AND SYSTEMS DESIGN[1/]

Systematic Approach to the Development of Business Information Systems

"SUPPLEMENTS"

by

A. Schinkel
The Netherlands Automatic Information
Processing Research Centre, Amsterdam

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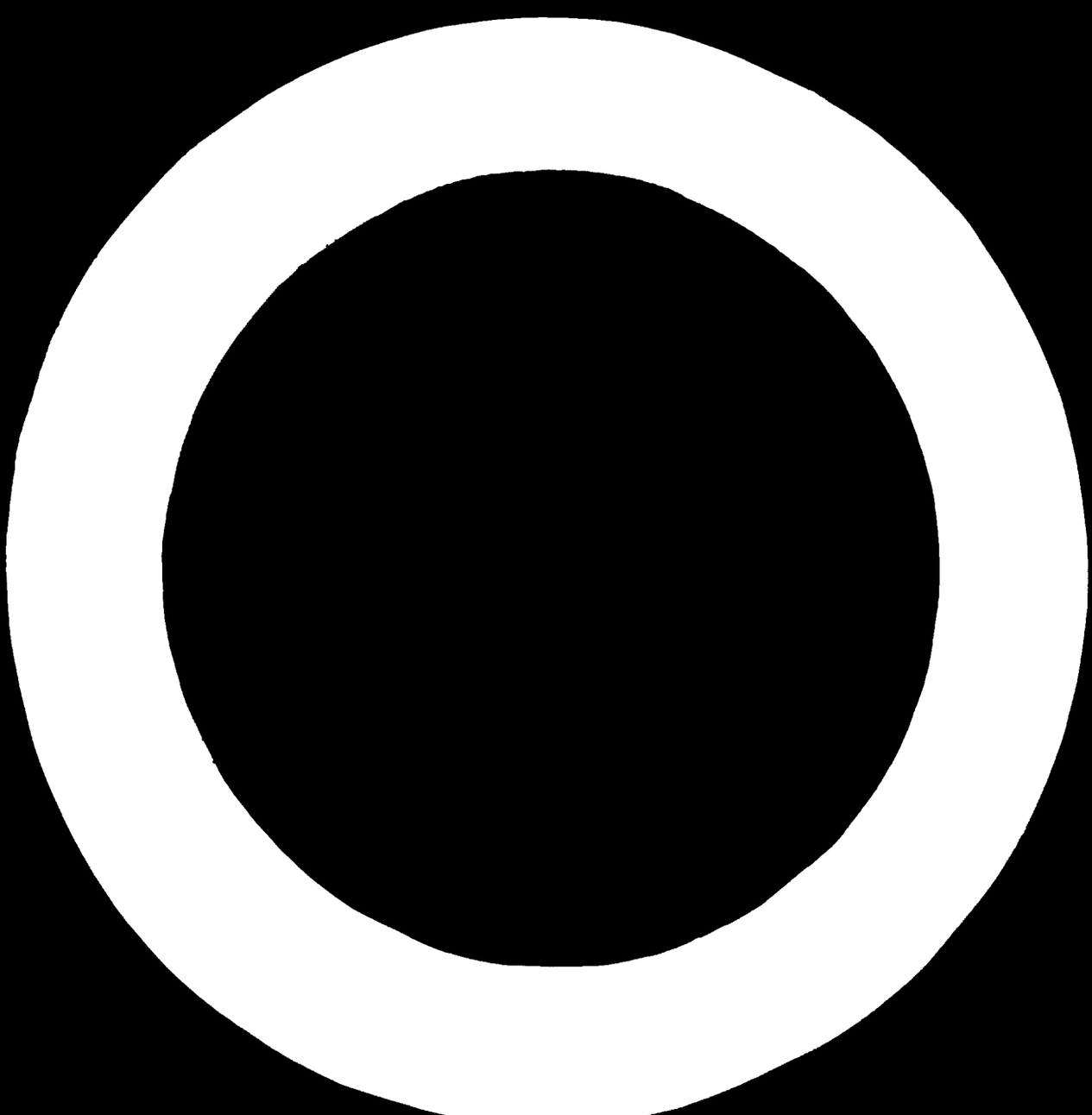

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- 3. Systemology for the design of a controlling system (New Version)
- 5. Documentation system for systems study (New Version)

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- 2. Methods of preliminary studies
- 3. Method of design studies (3.1 design of organization system)

KNOWLEDGE FOR DATA PROCESSING SPECIALISTS

1. GENERAL BASIC KNOWLEDGE
   - SECONDARY SCHOOL
   - PREPARATORY SCIENTIFIC EDUCATION
2. BASIC KNOWLEDGE OF BUSINESS
   1. BUSINESS ECONOMICS AND BUSINESS ADMINISTRATION
   2. BUSINESS MATHEMATICS AND BUSINESS STATISTICS
3. GENERAL KNOWLEDGE OF BUSINESS DATA PROCESSING
   1. HARDWARE AND SOFTWARE
      1. HARDWARE
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   2. SYSTEMS AND SYSTEM DESIGN
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   3. ORGANIZATION DATA PROCESSING
      1. ORGANIZATION AND CONTROL OF SYSTEM STUDY
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4. SPECIFIC KNOWLEDGE OF BUSINESS DATA PROCESSING
   - ADMINISTRATIVE ENTERPRISES
   - PRODUCTION ENTERPRISES
   - GOVERNMENTS
   - OTHER

KNOWLEDGE FOR DATA PROCESSING SPECIALISTS

3. GENERAL KNOWLEDGE OF BUSINESS DATA PROCESSING

3.2 SYSTEMS AND SYSTEM DESIGN

3.2.1 SYSTEMS

1. INFORMATION REQUIREMENT WITHIN THE ORGANIZATION

1. The information
2. Information as a tool of management
3. Information requirement and internal organization

2. INFORMATION HANDLING WITHIN THE ORGANIZATION

1. Information collection
2. Information processing
3. Information dissemination

3. THE BUSINESS AS A SYSTEM

1. The organization system
2. The information system
3. The processing system
4. The instruction system

3.2.2 SYSTEM DESIGN

1. STUDY SYSTEMS

1. Size and phasing of the automation process
2. Method of preliminary studies
3. Method of design studies
4. Method of realization-activities
5. Possibilities and constraints of study systems

2. STUDY METHODS

1. Design of code systems
2. Forms design
3. File organization
4. Study of work methods

3. STUDY TECHNIQUES

1. Techniques for analysis and design
2. Source documentations
3. Social techniques

3.2 SYSTEMS AND SYSTEM DESIGN

3.2.1 SYSTEMS

3.2.1.3 THE FIRM AS A SYSTEM

1. General

    1. The system concept
    2. The firm as a system
    3. Business systems and integration
    4. Distinguishing the system within the firm

2. The organization system

    1. What is understood by organization system
    2. Components and structure of an organization system (personnel)
    3. Organization system model (personnel)
    4. Components and structure of an organization system (hardware)
    5. Organization system model (hardware)

3. The information system

    1. What is understood by information system
    2. Components and structure of an information system
    3. Information system model

4. The information processing system

    1. What is understood by information processing system
    2. Components and structure of an information processing system
    3. Information processing system model

5. The instruction system

    1. What is understood by instruction system
    2. Components and structure of an instruction system (personnel)
    3. Instruction system model (personnel)
    4. Components and structure of an instruction system (hardware)
    5. Instruction system model (hardware)

6. Summary

    1. Significant differences
    2. A system through realization

Appendices

I. Organization system model (personnel)

Ia. Illustration of graph technique used

II. Organization system model (hardware)

IIa. Illustration of graph technique used

III. Information system model

IIIa. Illustration of graph technique used

IV. Information processing system model

IVa. Illustration of graph technique used

V. Instruction system model (personnel)

Va. Illustration of graph technique used

VI. Instruction system model (hardware)

VIa. Illustration of graph technique used

3.2 SYSTEMS AND SYSTEM DESIGN

3.2.2 SYSTEM DESIGN

3.2.2.1 STUDY SYSTEMS

1. Size and phasing of the automation process

    1. Introduction
    2. Phases of the automation process
    3. Continuity of systems study

2. Method of preliminary studies

    1. Study into operation of company
    2. Study into possibilities of automation

3. Method of design studies

    1. Definition of the problem
    2. Systems analysis in the automation process
    3. Starting points for the design method
    4. Aim of study
    5. Object of the analysis
    6. Order of the analysis
    7. Form and contents of the design methodology
    8. Information, organization, processes and methods
    9. Analysis, design and choice
    10. Outline and procedure
    11. Other characteristics of the method survey

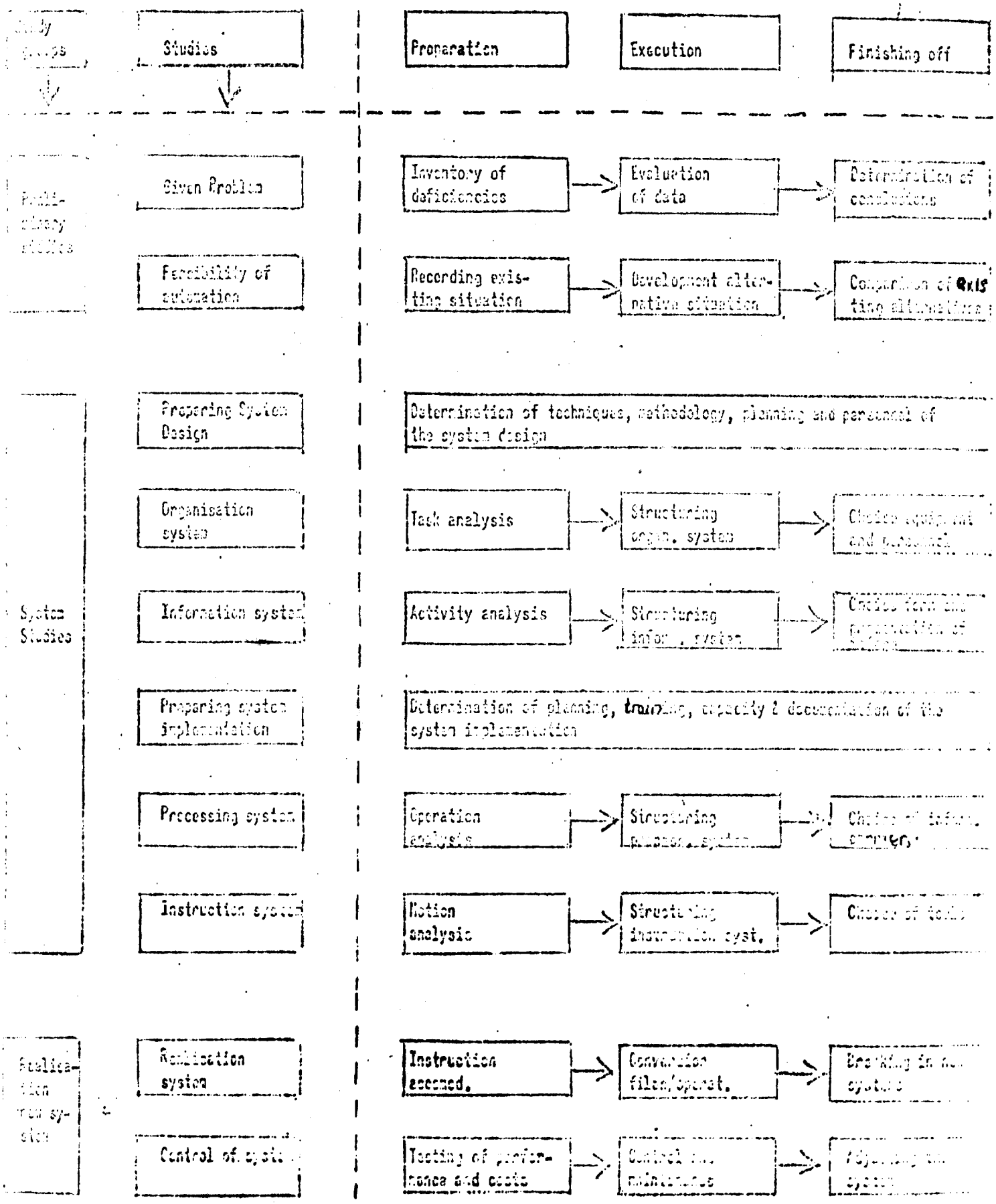
4. Method of realization-activities

    1. Introduction, site preparation conversion
    2. Testing, maintenance, etc.

5. Possibilities and constraints of study systems

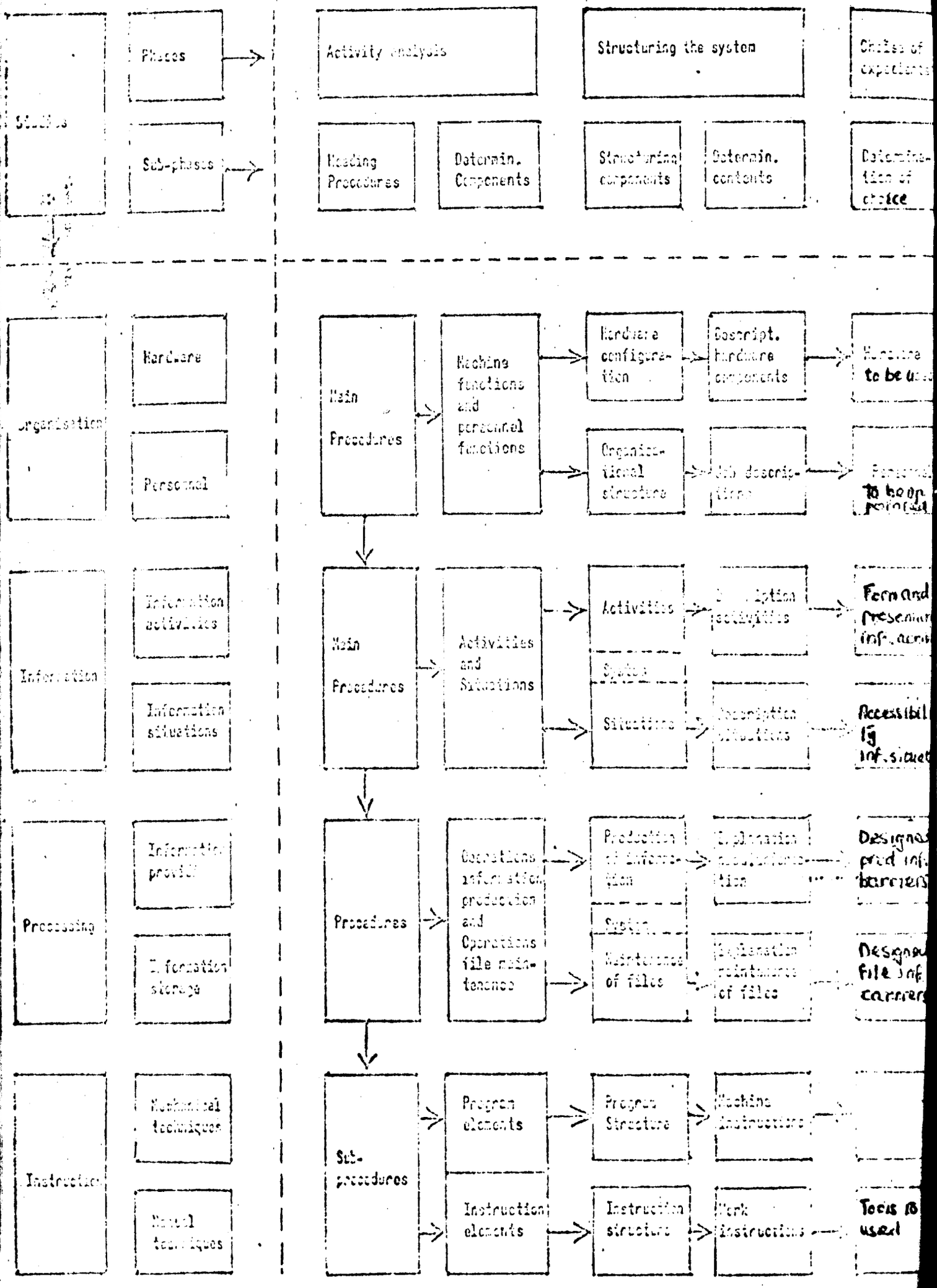
    - documentation of the survey
    - other dooumentation functions
    - training of systems designers
    - automation of systems study

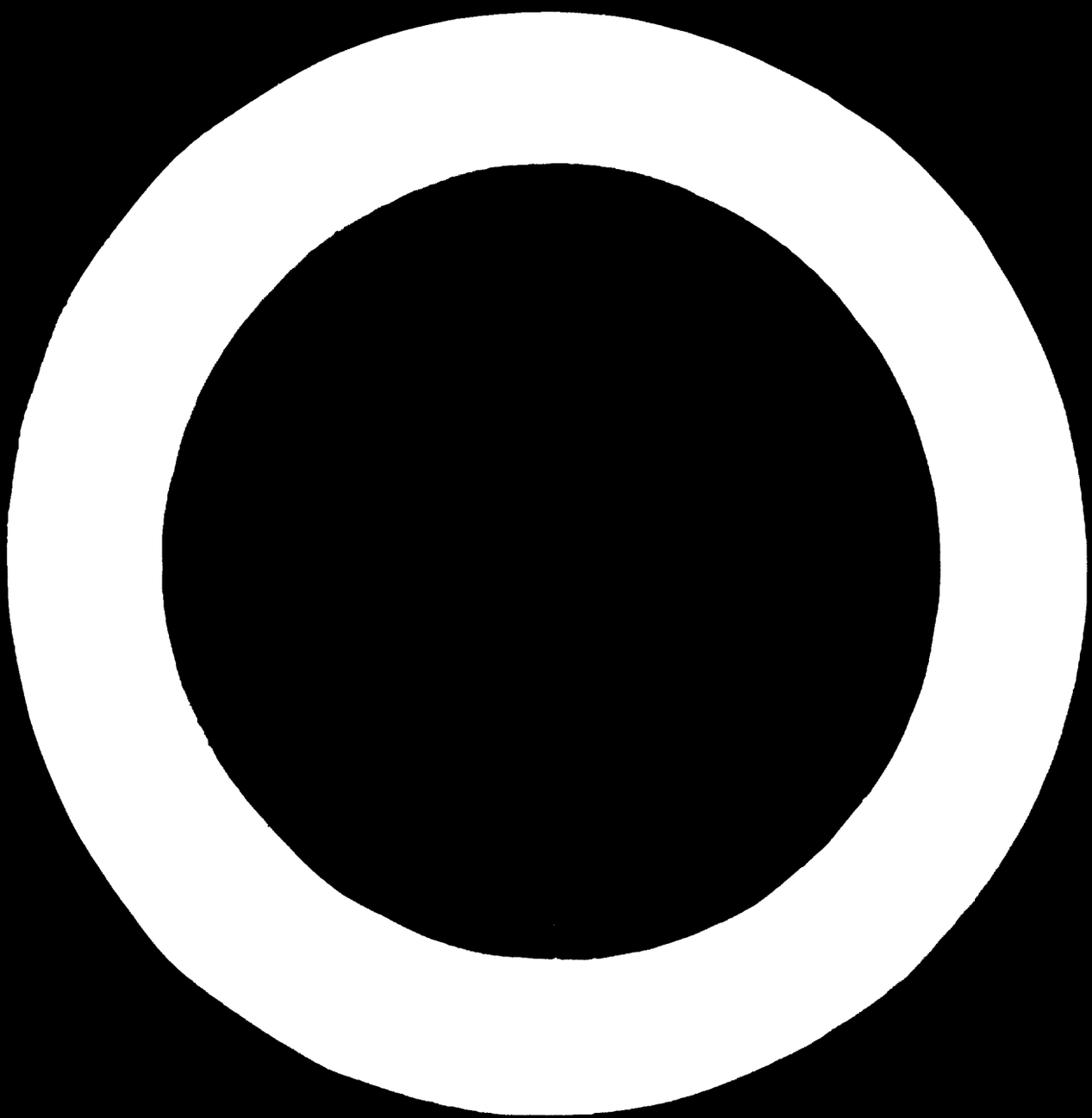
Methods for carrying out automation activities.

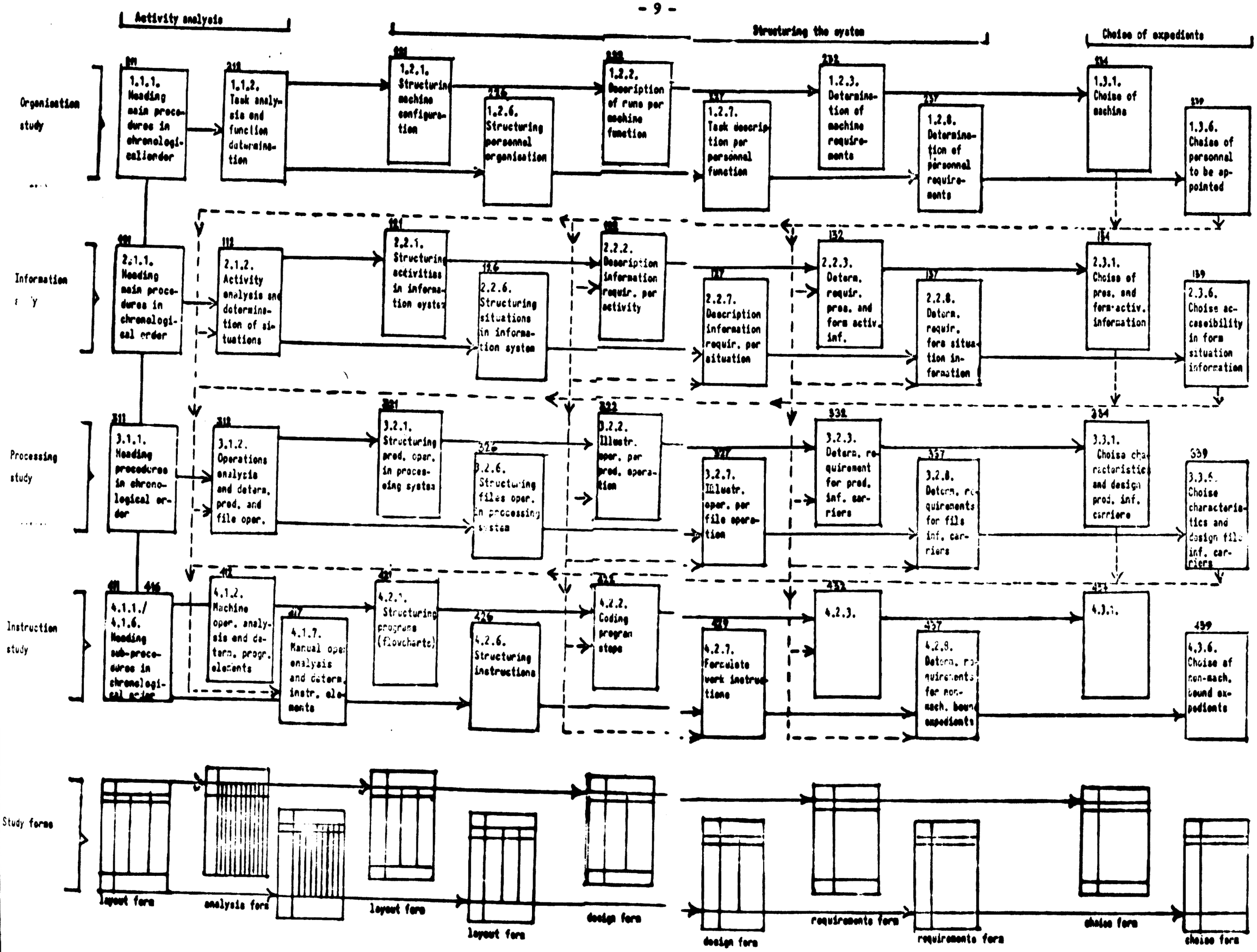


3.2.2.1.3.7. Structure of a design systemology

Systemology for the design of a controlling system






Activity analysis
Structuring the system
Choise of expedients
Organisation study
1.1.1. Heading main procedures in chronologicalorder
1.1.2. Task analysis and function determination
1.2.1. Structuring machine configuration
1.2.6. Structuring personnel organisation
1.2.2. Description of runs per machine function
1.2.7. Task description per personnel function
1.2.3. Determination of machine requirements
1.2.8. Determination of personnel requirements
1.3.1. Choise of machine
1.3.6. Choise of personnal to be appointed
Information study
2.1.1. Heading main procedures in chronological order
2.1.2. Activity analysis and determination of situations
2.2.1. Structuring activities in information system
2.2.6. Structuring situations in information system
2.2.2. Description information requir. per activity
2.2.7. Description information requir. per situation
2.2.3. Determ. requir. pres. and form activ. inf.
2.2.8. Determ. requir. form situation information
2.3.1. Choise of pres. and form activ. information
2.3.6. Choise accessibility in form situation information
Processing study
3.1.1. Heading procedures in chronological order
3.1.2. Operations analysis and determ. prod. and file oper.
3.2.1. Structuring prod. oper. in processing system
3.2.6. Structuring files oper. in processing system
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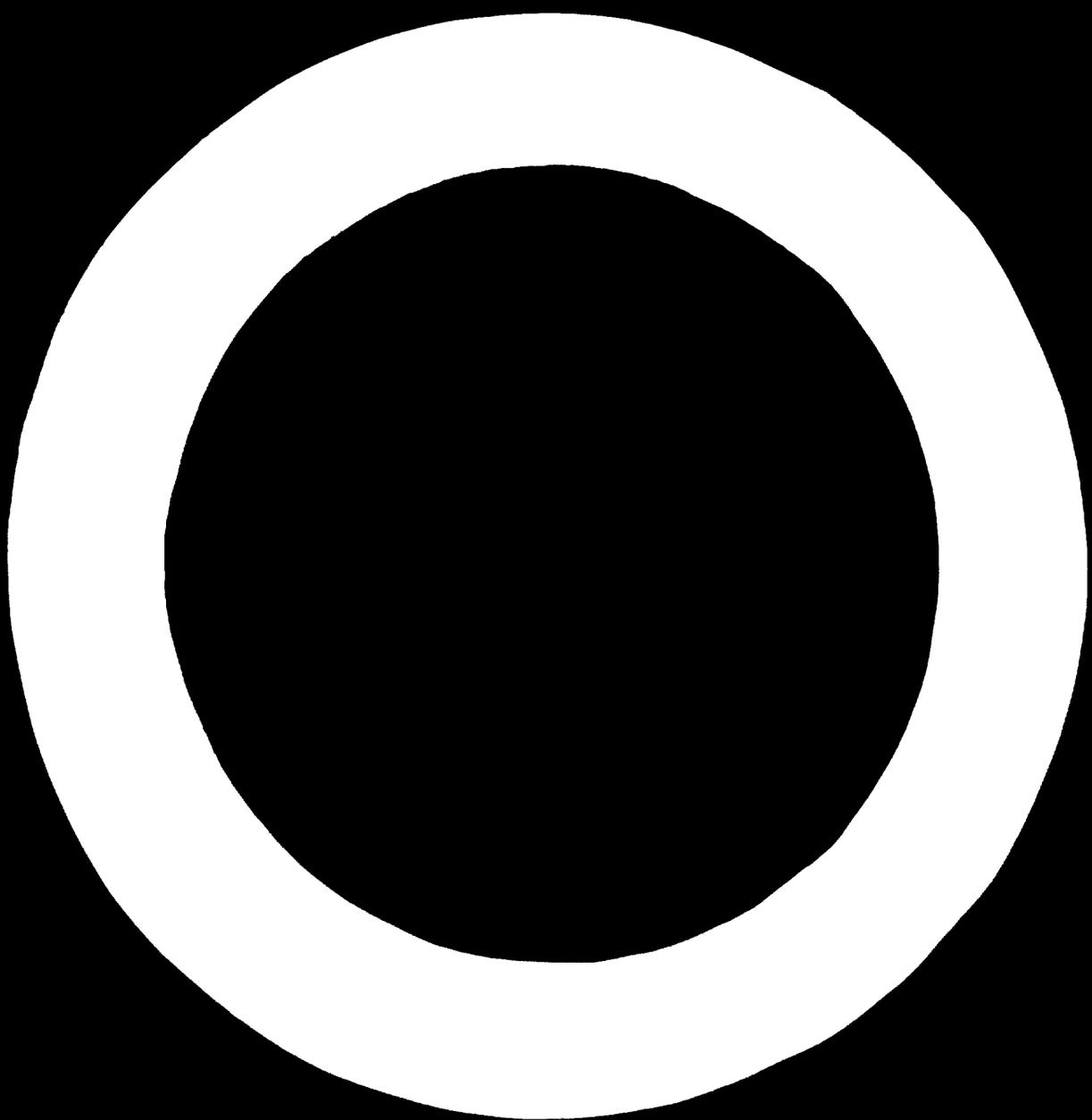
3.2.7. Illustr. oper. per file operation
3.2.3. Determ. requirement for prod. inf. carriers
3.2.8. Determ. requirements for file inf. carriers
3.3.1. Choise characteristics and design prod. inf. carriers
3.3.6. Choise characteristics and design file inf. carriers
Instruction study
4.1.1./ 4.1.6. Heading sub-procedures in chronological order
4.1.2. Machine oper. analysis and determ. progr. elements
4.1.7. Manual oper. analysis and determ. instr. elements
4.2.1. Structuring programs (flowcharts)
4.2.6. Structuring instructions
4.2.2. Coding program steps
4.2.7. Formulate work instructions
4.2.3.
4.2.8. Determ. requirements for non-mach. bound expedients
4.3.1.
4.3.6. Choise of non-mach. bound expedients
Study forms
layout form
analysis form
layout form
layout form
design form
design form
requirements form
requirements form
choise form
choise form



3.2.2 SYSTEM DESIGN

1. STUDY SYSTEMS

2. Study into operation of company
(General preliminary study)

The purpose of this study is to gain an insight into the way the company is operating and, more in particular, whether a further study into the possibilities of automation is desired (feasibility study, system study or such).

Stages in study:

1. Giving order
   - determining aim and contents of study
   - appointing responsible functionary
   - determining procedure, term and costs

2. Orientation of company
   - purpose, functions and activities (appendix I)
   - size of the company (output, costs, personnel) (appendix II)
   - organization of the company (static, departments) (appendix III)
   - organization (dynamic, rocedures) (appendix IV)
   - administration of the company (number of transactions and accounts (appendix V)

3. Inventory of flaws in company
   - use of check lists for aims and possibilities of automation (ADP objectives; appendix VI)

4. Determining desirability of further study
   - critical evaluation of noted facts
   - consideration of consequences of possible changes
   - formulating conclusions

5. Reporting on study results
   - reporting procedure (orally, in writing, mixed form)
   - structure and contents of report
   - dealing with the report

3. Study into the possibilities of automation (feasibility study)

This study should be looked upon as a study into the economic efficiency of an alternative system, using electronic equipment. This will develop into a cost comparison between the existing system and the most advantageous alternative system. The study should provide an answer to two questions, namely: is it efficient, now or in the near future, to automate, and if so, at what level of automation should the further study be aimed?

Study stages (practical example):

1. Global survey of existing system
   - information processing and presentation (input/output schedule)
   - total costs of existing system (from cost administration) (appendix VII)
   - present views with respect to improvement (administrative, technical, managerial)

2. Developing alternative system
   - preliminary determination of principal configurations (card, tape and/or disk)
   - global design of alternative system (partial input/output schedules)
   - global inventory of possible advantages (descriptive)

3. Comparing existing and alternative system
   - estimated primary savings (appendix VIII)
   - determining total value of advantages (appendix IX)
   - determining conversion costs (appendix XI)
   - determining efficiency of alternative system (appendix XII)

Literature

Lech, F.J.
Shortcuts in conducting a computer feasibility study for small and medium size companies
New York, Diebold Group, 1961, 26 pp.

Trail, J.R.
Analysing the desirability of acquiring an electronic computer.
From: The Internal Auditor, 20 (1963) No. 1, pp. 37 - 49

General Pre-study

DESCRIPTION OF THE COMPANY*

(Company for the production and sale of electronic equipment).

PURPOSE, FUNCTIONS AND ACTIVITIES

Statutory aim

The purpose of the enterprise is the manufacturing and selling of electronic equipment, as well as the trade and investment in movables and real estate, import and export of trade goods, the representation of business houses at home and abroad and the performance of everything, related to the above in the broadest sense, including participating in, financial interest in, and management of enterprises with the same or related objectives.

Present activities

Production of radios, television sets, gramophones and tape recorders for domestic use and sale by retail trade of this equipment to private persons in the home market In accordance with the character of the products and the production process purchase of raw materials and manufacturing of products is for stock.

Planned activities

Sale of equipment to the export market by means of importers.

---

* Imaginary company as model for the performance of a system study.

SIZE OF THE COMPANY

The company belongs to the category of medium-sized enterprises.

Sales

-	Radios (40,000 sets; average price	$250.--)	$10,000,000.--
-	Television sets (30,000 sets; average price	$800.--)	$24,000,000.--
-	Gramophones (15,000 sets; average price	$150.--)	$ 2 250,000.--
-	Tape recorders (5,000 sets; average price	$200.--)	$ 1,000,000.--
-	Miscellaneous;		$ 150,000.--
Total Sales			$37,400,000.--

Costs

-	Materials (raw and auxiliary materials)	$10,000,000.--
-	Machines (depreciation, rent etc.)	$ 5,000,000.--
-	Personnel (direct and indirect personnel)	$11,200,000.--
-	General (management, accounting, building, etc.)	$11,200,000.--
Total Costs		$37,400,000.--

Properties

-	Ground and buildings	$30,000,000.--
-	Machines and other equipment	$50,000,000.--
-	Stocks	$10,000,000.--
-	Claims	$ 5,000,000.--
Total of properties		$95,000,000.--

Debts

-	Mortgage	$10,000,000.--
-	Loans	$50,000,000.--
-	Various debts	$ 5,000,000.--
-	Share capital	$30,000,000.--
Total of debts		$95,000,000.--

Personnel

-	Workers (mail and female)	900
-	Technicians	80
-	Commercial personnel	30
-	Clerical personnel	60
-	Management personnel	50
Total number of persons		1,120

ORGANIZATION OF THE COMPANY

The organizational structure* of the company is as follows:-

0. Executive Office

- 0.1 Personnel Administration
- 0.2 External Relations
- 0.3 Secretarial and Legal

1. Research and Development

- 1.1 Basic and Applied Research
- 1.2 Product and Process Development
- 1.3 Product Engineering

2. Production

- 2.1 Plant Engineering
- 2.2 Industrial Engineering
- 2.3 Purchasing
- 2.4 Materials and Tools
  - 2.4.1 Factory Receiving
  - 2.4.2 Store-keeping Raw Materials
  - 2.4.3 Store-keeping Parts and Sub-Assemblies
  - 2.4.4 Internal Transport
  - 2.4.5 Tools Procurement
- 2.5 Production Planning
- 2.6 Manufacturing
  - 2.6.1 Manufacture of Parts
  - 2.6.2 Sub-Assembly
  - 2.6.3 Final Assembly
  - 2.6.4 Service and Repair
- 2.7 Quality Control

3. Marketing

- 3.1 Market Research
- 3.2 Advertising
- 3.3 Sales Promotion
- 3.4 Sales Planning
- 3.5 Sales Operations
- 3.6 Distribution
  - 3.6.1 Warehousing
  - 3.6.2 Shipping
  - 3.6.3 Product Service

---

* The structure of the organisational (often hierarchic) relations between groups of responsibilities determined according to persons

4. Finance and Control

4.1 Finance
4.2 Control

4.2.1 Payroll Accounting
4.2.2 Cost Accounting
4.2.3 Bookkeeping
4.2.4 Internal Auditing

4.3 Data Processing

PROCEDURES OF THE COMPANY

The activities of the company are performed within the framework of the following procedures*:-

1. Preparation of Activities

1.1 Market Analysis
1.2 Product Requirement Determination
1.3 Product Engineering
1.4 Analysis Production Organization
1.5 Design Machine Organization
1.6 Choice of Specific Machines
1.7 Design Personnel Organization
1.8 Choice of Specific Personnel
1.9 Establishing Overall Planning
1.10 Realization modifications Production Organization

2. Sales

2.1 Specifying Sales Planning
2.2 Advertising
2.3 Order Handling

2.3.1 Order Acceptance
2.3.2 Order Pre-working
2.3.3 Order Confirmation
2.3.4 Handling Credit Exceeds

2.4 Shipping
2.5 Invoicing
2.6 Settling with Customers
2.7 Preparing Sales Reports

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* Purpose-oriented, mostly ordered sequence of necessary actions for obtaining systematic settlement of specific operations.

3. **Manufacturing**

- 3.1 Specifying Production Planning
- 3.2 Production Control Parts
  - 3.2.1 Preparing Production Forms
  - 3.2.2 Procurement of Raw Materials
  - 3.2.3 Dispatching
  - 3.2.4 Quality Control
  - 3.2.5 Storing Parts
- 3.3 Production Control Sub-Assemblies
  3.3.1/3.3.5 (as 3.2)
- 3.4 Production Control Apparatus
  3.4.1/3.4.5 (as 3.2)
- 3.5 Paying Production Workers
- 3.6 Preparing Production Reports

4. **Purchasing Direct and Indirect Materials**

- 4.1 Specifying Purchasing Planning
- 4.2 Offer Handling
- 4.3 Ordering
- 4.4 Receiving
- 4.5 Checking Invoices
- 4.6 Settling with Vendors
- 4.7 Preparing Purchasing Reports

5. **Maintaining Working Means and Relations**

- 5.1 Maintaining Buildings, Installations, etc.
- 5.2 Maintaining Machines, Tools, etc.
- 5.3 Maintaining Personnel
- 5.4 Maintaining External Relations

6. **Finishing Activities**

- 6.1 Paying General Personnel
- 6.2 Company Accounting
- 6.3 General Accounting
- 6.4 Settling with Financiers and Investors
- 6.5 Organizing General Meeting Stockholders
- 6.6 Settling with Stockholders

ADMINISTRATION OF THE COMPANY

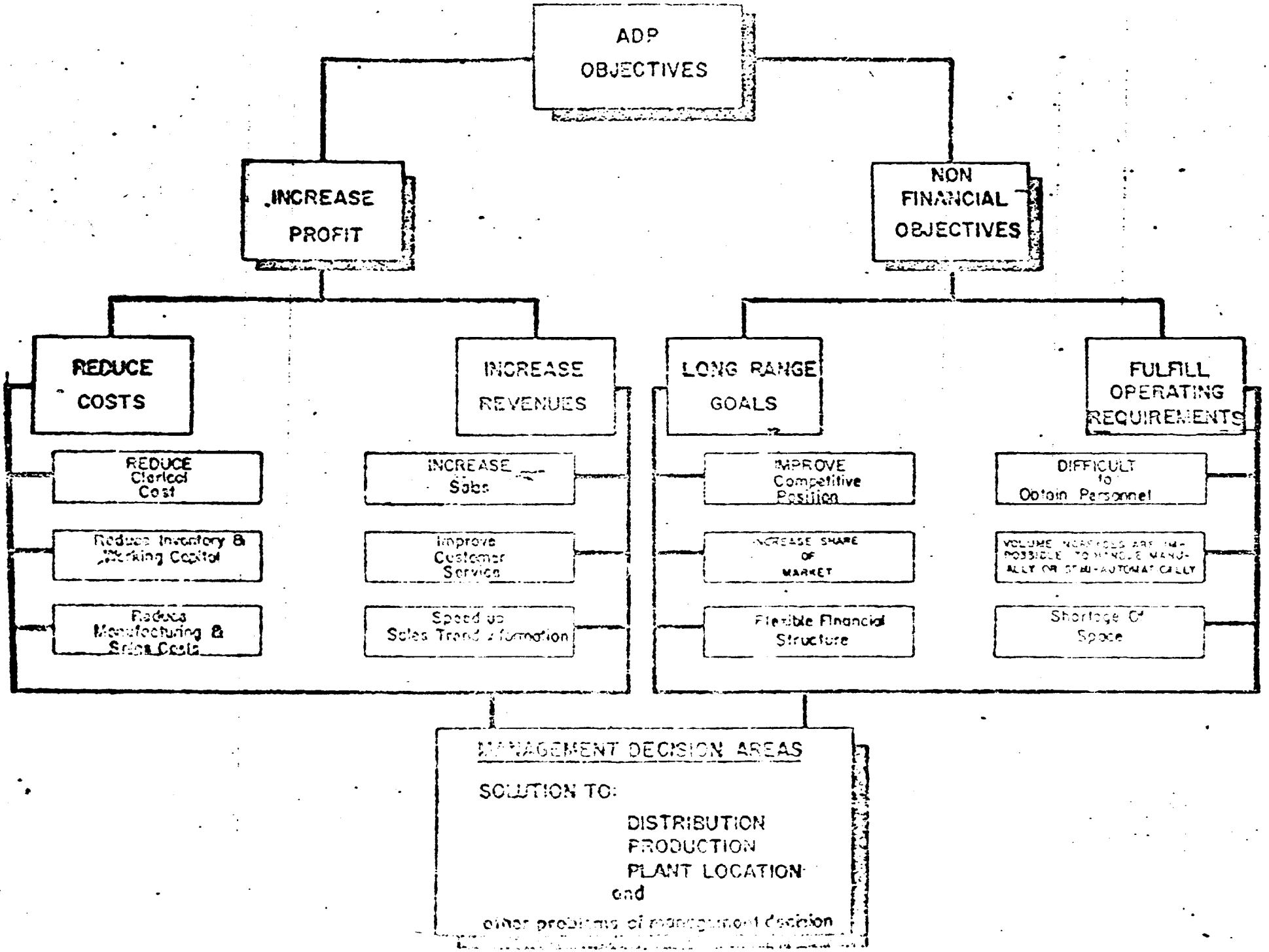
The following numbers have to be handled by the administration of the company:-

Number per Activity

-	Sales Letters/Folders (quarterly)	4,000
-	Sales Orders (Daily)	300
-	Deliveries (Daily)	350
-	Outgoing Invoices (Weekly)	800
-	Payments of Customers (Daily)	100
-	Production Orders Parts (Weekly)	500
-	Issues of Raw Materials (Daily)	100
-	Receivings of Parts (Daily)	200
-	Assembly Orders, Sub-assemblies (Weekly)	350
-	Issues of Parts (Daily)	700
-	Receivings of Sub-assemblies (Daily)	200
-	Assembly Order Apparatus (Weekly)	200
-	Issues of Sub-assemblies (Daily)	800
-	Receivings of Apparatus (Daily)	400
-	Recording beginning and ending time (Daily)	2,200
-	Wages Accounts (Weekly)	900
-	Received Offers (Daily)	50
-	Purchase Orders (Weekly)	100
-	Factory Receivings (Daily)	30
-	Received Invoices (Weekly)	80
-	Payments to Vendors (Weekly)	60
-	Salary Accounts (Monthly)	220
-	Entries Company Accounting	5,000
-	Entries General Accounting	1,000
-	Rent Payments Investors (Quarterly)	600
-	Invitations Stockholders (Yearly)	2,000
-	Dividend Payments Stockholders (Yearly)	2,000

Accounts per File

-	Prospects	3,000
-	Customers	1,000
-	Types of Raw Material	700
-	Types of Parts	12,000
-	Types of Sub-assemblies	7,000
-	Types of Equipment	2,000
-	Suppliers	500
-	Vendors	200
-	Types of Costs	300
-	Places of Cost (Departments)	50
-	Carriers of Cost (Groups of Products)	160
-	Other Accounts	100
-	Bondholders	600
-	Stockholders	2,000


ADP OBJECTIVES
INCREASE PROFIT
NON FINANCIAL OBJECTIVES
REDUCE COSTS
INCREASE REVENUES
LONG RANGE GOALS
FULFILL OPERATING REQUIREMENTS
REDUCE Clerical Cost
Reduce Inventory & Working Capital
Reduce Manufacturing & Sales Costs
INCREASE Sales
Improve Customer Service
Speed up Sales Trend Information
IMPROVE Competitive Position
INCREASE SHARE OF MARKET
Flexible Financial Structure
DIFFICULT to Obtain Personnel
VOLUME WORKLOADS ARE IMPOSSIBLE TO HANDLE MANUALLY OR SEMI-AUTOMATICALLY
Shortage Of Space
MANAGEMENT DECISION AREAS
SOLUTION TO:
DISTRIBUTION
PRODUCTION
PLANT LOCATION
and
other problems of management decision

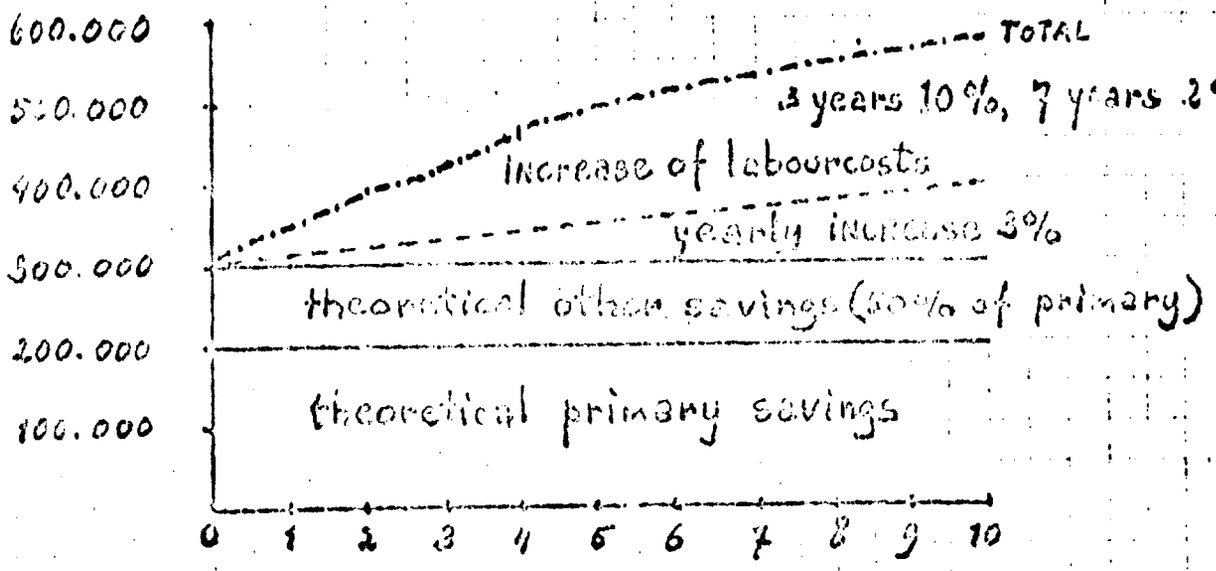
TOTAL COSTS OF EXISTING SYSTEM

Department	Actual Costs				
	Personnel	Machines	General cost (own dept.)	General cost (overhead)	Total
A Purchase Admin.	89,000	200	7,000	49,000	145,800
B Store Articles	125,000	100	24,800	67,900	217,800
C Iron	84,000	-	15,000	84,000	183,000
F Central Planning	34,000	200	1,500	30,800	66,500
G Production Control CW	119,000	700	5,200	36,700	161,600
H Production Control MF	73,000	600	4,200	22,800	100,600
K Store Accounting	27,000	100	1,200	1,700	30,000
L Wages Department	41,000	1,300	4,900	30,000	127,200
M Personnel Department	-	100	2,000	44,300	46,400
N Pre-calculation	75,000	100	5,000	74,800	154,900
O Post-calculation	58,500	600	3,700	5,000	67,800
P Bookkeeping	102,000	1,000	6,200	29,000	138,200
Q Internal Accounting Department	43,000	500	3,100	24,900	71,500
R Punched card machine Department	48,000	68,000	16,800	30,900	163,700
S Pay Office	29,000	200	1,300	1,700	32,200
U Invoice Check	42,000	400	2,500	3,300	48,200
	1,110,500	74,400	108,000	578,400	1,871,300

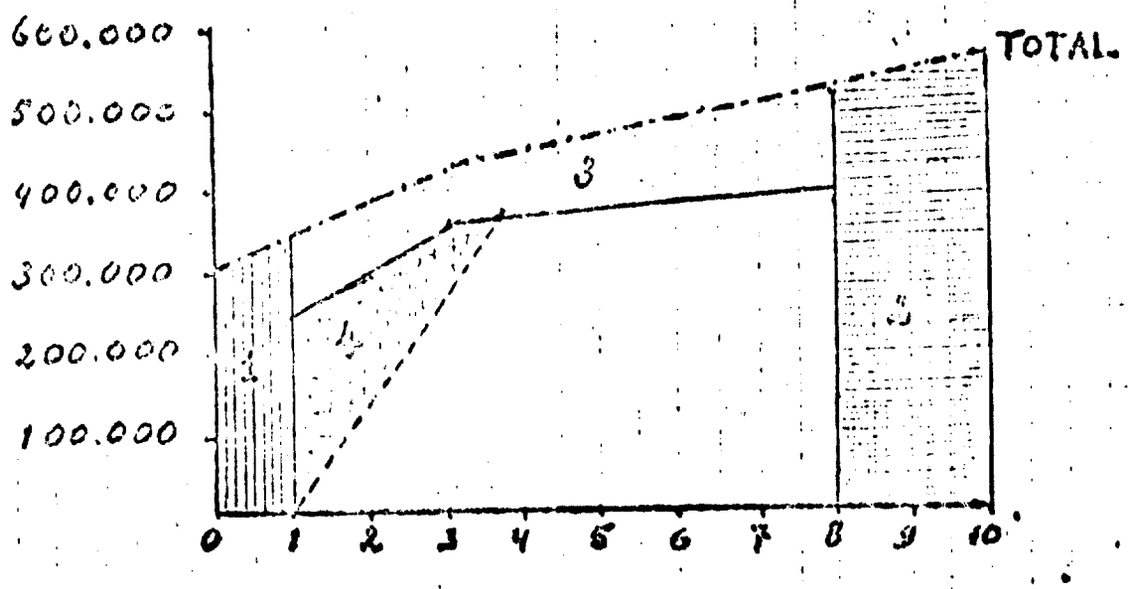
Estimated Saving of Personnel of Wages Department

Persons \ Type of Work	Management and Various	Clock cards	Tariff calculation	Mass-Tariff calculation	Filling out time-table of assembly	Filling out hours for travelling	Preparation of timetables	Regulations wage sequestr	Pam. allowances/ damages/working clothes	Health Ins. a. W.C.A. activities	Mutations, rent compensations	Mutations, work. clothes	Mutations, pension fund	Clearance Dept. Workers	Filling Pay Envelopes	Information	Planning	Under Contractors	Total
Van Stigt	100																		100
Dekkers	30	20						20			10			20					100
Van Zuyl		20	20									10				10		40	100
Meijer	40	20	10		10	10							10						100
De Boer		20	50				30												100
Latensteyn		20		20													60		100
Van Duyk		20	50				30												100
De Haas	100																		100
Mej. Woning	100																		100
V d. Heuvel									80						20				100
Nieuwstraten		20								60					20				100
Totals	3..	140	130	20	10	10	60	20	80	60	10	10	10	20	40	10	60	40	1,100
Savings ( )	40	25	100	100	100	100	100	0	0	0	50	50	50	20	25	0	80	60	
Savings (Personnel)	1.5	0 4	1 3	0 2	0.1	0.1	0.6	0	0	0	0.1	0.1	0.1	0	0.1	0	0.5	0.2	5.3

GRAPH DESCRIBING TOTAL PROFITS-SURPLUS



CORRECTIONS



1 = equipment will be delivered after one year
2 = economical term of live is seven years
3 = convertable savings 75%
4 = preamble correction 3 years after installation

Determination of Total Value Revenues*

Estimated Savings per Year $222,000.--

Deduct provision setbacks 25% $ 55,500.--

$166,500.--

To be Released Year		Increases in Prices Year	
1. (year of order)	0%	1. 0 - 10%	= 5%
2. 0 - 50% =	25% av.	2. 10 - 20%	= 15%
3. 50% - 80% =	65% av.	3. 20 - 30%	= 25%
4. 80 - 100% =	90% av.	4. 30 - 32%	= 31%
5.	100%	5. 32 - 34%	= 33%
6.	100%	6. 34 - 36%	= 35%
7.	100%	7. 36 - 38%	= 37%

Savings in 7 years

Year

1.

2. $0.25 \times 1.15 \times 166{,}500 \times \frac{1}{1.042}$ ** = 44,300

3. $0.65 \times 1.25 \times 166{,}500 \times \frac{1}{1.043}$ = 120,300

4. $0.9 \times 131 \times 166{,}500 \times \frac{1}{1.044}$ = 167,800

5. $1.- \times 1.33 \times 166{,}500 \times \frac{1}{1.045}$ = 182,000

6. $1.- \times 1.35 \times 166{,}500 \times \frac{1}{1.046}$ = 180,000

7. $1.- \times 1.37 \times 166{,}500 \times \frac{1}{1.047}$ = 173.300

$868,000

* Savings that cannot be quantified are not included.

** Constant value, if order is placed now.

Calculation of conversion costs

1.	**Systems Analysis**		
	- System Analyst (1½ year)	$23,000.—	
	- Management and principal Setup (3/4 year)	$18,000.—	
	- External Consultant	$ 3,000.—	
			$44,000.—
2.	**Programming**		
	- 1½ year full time		$20,000.—
3.	**Set up New Files**		
	- Coding (comparison values VC)		PM
	- Preparing for punching		PM
	- Punching		$ 3,000.—
4.	**Parallel Running**		
	- See Start-up Losses		PM
5.	**Test Running Service Bureau**		
	- Wage Programme (4 hrs. x Hfl 250.—)		$ 1,000.—
6.	**Personnel costs**		
	- Recruitment	$ 1,000.—	
	- Training (15 day course plus one month practicing)		
	- 3-Man programming	$ 4,000.—	
	- 2-Man systems analysis	$ 6,600.—	
			$11,500.—
7.	**Preparation machines room**		$10,000.—
Total Conversion			$89,500.—

COST COMPARISON

Number of Years	Savings	Costs			Difference	
		Equipment	Others*	Total	Advant.	Disadvant.
6	515,000.--	384,000.--	165,000.--	549,000.--		34,000.--
7	695,000.--	458,000.--	180,000.--	638,000.--	57,000	
8	868,000.--	529,000.--	195,000.--	724,000.--	144,000	

* Hfl. 90,000.-- switching costs plus other exploitation costs

Savings resp. advantages (not to be quantified)

1. Data available more quickly
2. More possibilities -
   (a) More and better planning data (a.o.th. by Port) resulting in
      - quicker run-through of products
      - more accurate and more frequent result surveys (specifications)
   (b) More and better basic data for pre-calculation
   (c) Inserting decentral departments in data systems
3. Less personnel problems
   (a) Less people
   (b) Better quality of people
4. Less room problems due to point 3
5. Reserve capacity of computer available.

3.2.2 SYSTEM DESIGN

1. STUDY SYSTEMS

3. Methodology of design studies

0. General
1. Basic elements in methodology
2. Methodology structure
3. Methodology contents
    0. General
    1. Design of organization system
        1. Job analysis
            1. Determining and sectioning main procedures
            2. Definitions of functions
        2. Structure of organization system (hardware)
            1. Structuring hardware configuration
            2. Description hardware components
            3. Determining hardware requirements
        2. Structure of organization system (personnel)
            6. Structuring personnel organization
            7. Description of personnel functions
            8. Determining personnel requirements
        3. Choice of hardware to be used
            1. Determining and sectioning alternative hardware
            2. Comparison and choice of hardware
        3. Choice of personnel to be engaged
            6. Determining and sectioning alternative candidates
            7. Comparison and choice of candidates
        2. Design of information system
        3. Design of processing system
        4. Design of instruction system

1. DESIGN OF ORGANIZATION SYSTEM

1.1 JOB ANALYSIS

1.1.1 Determining and sectioning main procedures

The first step in the design of the organization system is the analysis of the various jobs. This analysis is made per procedure: first of all an inventory is made of the main procedures, for the purpose of obtaining separate (complete) components as the starting point for the analysis. The main procedures consist of a number of chronologically consecutive jobs aimed at the performance of a specific business function. (e.g., provision for resources, production, product marketing, etc.)

An important criterium with the distinction of main procedures is, that they should not be too long, since the overall survey is less easily obtained, yet not too short, since then one will not be able to obtain an insight into the interrelations.

Procedures may be broken off on the moment of:-

- a change of resources (people or machines)
- a change of place (both internal and external)
- a change of periodicity
- a change of information (basic data or end data)
- convergence or division of procedures
- ?

The main procedures which have to be determined are sectioned again into chronological order.

1.1.2 Job definition

Determining the functions for the new system actually means distributing the jobs. This means that jobs which are chronologically sectioned within the procedures are again sectioned, this time according to functions or job combinations per employee.

Job Analysis

However, before making this division it is desirable to first analyse the job as such. By job is understood: a number of chronologically consecutive operations constituting a unit, in this sense that they may - in principle - be executed by one employee or by one machine.

Of course one employee or one machine is capable of executing several jobs. It also applies to the job that it may not be too big, since in that case the advantages of functional specialization are not used in full, yet not too small, since then too many communication problems will occur. With job analysis the following questions should be considered:

- is the job necessary
- might it not be better to divide the job into sub-jobs?
- is it possible to turn part of the job into a preparatory stage?
- is it possible to turn part of the job into a checking stage?
- is it possible to combine a number of jobs?
- ?

Subdividing the personnel jobs

The purpose here is to determine the component parts the organization (organizational structure) should be composed of. This does not only relate personnel who are primarily charged with information processing, but to all personnel at the firm. Criteria for dividing are:-

- type of work (capability classes of personnel)
- quantity of work (adapted to a multiple of personnel, i.e. units of 40 hours/week)
- available time (in case of not much time, less separation of jobs)
- work level (within one job as few variations in work level as possible)
- internal checking (no combination of jobs if checking would suffer from it)
- interrelation of jobs
- ?

1.2 STRUCTURE OF ORGANIZATION SYSTEM (HARDWARE)

The structure of the organization system with respect to hardware is realized in two stages, namely: the structuring of the hardware components which were obtained during the preceding analytic stage, into a hardware configuration, followed by a description of these components in the form of jobs to be carried out and demands to be made from these components.

1.2.1 Structuring hardware configuration

First of all the principle organization is determined, i.e. a choice should be made with respect to the following possibilities:

- batch processing or real time processing
- data transport via information carrier or transmission line
- central or semi-central processing (satellite hardware)
- ?

The most important criteria for choosing each one of these possibilities are:

Batch processing or real time processing:-

- desired frequency of information presentation
- costs of direct access
- ?

1. DESIGN OF ORGANIZATION SYSTEM

Data transport via information carrier or transmission line:

- desired frequency of information presentation
- time needed for data transport via information carrier
- cost of transmis ion line and required central equipment
- ?

Central or semi-central processing:

- decentralised information presentation from both small and large equipment
- costs of direct access and transmission line
- ?

On the basis of the ohosen prinoipal configuration the provisionally prepared oomponents are struotured into a configuration, in whioh the following oomponent categories are distinguished:

- oentral processing unit
- oentral on-line processing units
- central on-line peripherals
- remote on-line processing units
- remote on-line peripherals
- central off-line processing units
- central off-line peripherals
- remote off-line processing units
- remote off-line peripherals
- central system-independent hardware
- ?

For each oategory mentioned above next a provisional choice is made with respect to the most important requirements:

For the central processing unit:

- processing speed
- storage capacity
- number of channels
- multiprogramming facility
- number of units
- ?

On-line processing unit (central and remote):

- processing speed
- storage capacity
- access time
- number of units
- ?

On-line peripherals (central and remote):

- hardware classes
- Access time
- number of units
- ?

Off-line processing units (central and remote):

- processing speed
- storage capacity
- number of channels
- number of units
- ?

Off-line peripherals (central and remote):

- hardware classes (functions)
- capacity
- speed
- number of units
- ?

Central system - independent hardware:

- hardware classes (functions)
- number of units
- ?

The latter category includes machines which have a specific and permanent position within the system. Universally and individually applicable machines belong to the class of resources which will be dealt with at a later stage of the study.

All components are assigned a code number, indicating the position of the components within the configuration structure.

1.2.2 Description of hardware components

For each hardware component a description is given of the jobs they should carry out. First of all, all jobs are enumerated, in chronological order, which have been assigned to the various components with the distribution of the jobs. Then, each job is briefly illustrated, with respect to data which are decisive for the requirements to be made from the components. To this data are added: the periodicity and the moment within periodicity, as well as the number of times the jobs should be carried out per period. Finally, with each job, its dependence from other components is determined, for the purpose of being able, when handling the data, to determine the relation with other components in the configuration.

1.2.3. Determining hardware requirements

Following the elaboration and description of jobs, the requirements are derived which the components should meet. This means that, for each component, first the classes of requirements are determined, and next, per requirement class, the specific requirements are determined. In principle, the latter are determined by checking, for each job, what are the requirements for the job, and then copying the highest level one.

This should, of ocurse, be done only if this highest-level requirement does not solely apply to a too small portion of the total of jobs. In general, requirements will relate to the technical possibilities and to capacity. With the aid of e.g. capacity calculations finally the desired speed is determined. Of course, hours which are not available for direct production should be taken into account. These e.g. include:

- conversion operations (new applications)
- testing hours (both for new programmes and for modified, existing programmes)
- setting times (both for loading the programme and for changing magnetic tapes, etc.)
- preventive maintenance (both daily clearing and smaller revisions)
- breakdowns as the result of organizational errors (input data too late, errors in input data, errors committed by operating personnel)
- breakdowns as the result of machine errors (breakdowns in hardware, electricity and air conditioning failure)

The losses of time mentioned above may be compensated for by the fact that it is always possible to operate the hardware in several shifts, so the actual available time may be twice, or even three times as much. As far as the requirements, specified during the elaboration of the configuration are different from the requirements observed with the initial configuration structuring, the latter are corrected.

1.3 CHOICE OF HARDWARE TO BE USED

On the basis of the requirements mentioned sub 1.2.3, the hardware which qualifies for a choice is determined and the choice is made by comparison.

1.3.1 Determining and sectioning alternative hardware

In order to be able to make a choice the data on qualifying machines should be collected. A first selection may be made on the basis of general hardware documentation. Examples:

- Computer Characteristics (ed. Netherlands ADP Research Centre)
- Office Machine Guide (ed. Intern. Off. Mach. Research)
- Auerbach (USA)
- Niederberger (Switzerland)
- ?

Next, documentation and offers are requested from the provisionally selected, manufacturers. Finally, the received information is divided into sections, so that the various hardware characteristics and specific manufacturer features may be compared. Factors which may be compared are:

Hardware

- processing unit characteristics
- peripherals characteristics
- speeds and processing times
- working store capacity
- instructional system
- simultanity
- ?

Software

- programming techniques
- test programme
- standard programmes
- standard systems
- simulators
- ?

Costs

- hardware
- software
- programme conversion
- Other
- ?

Various factors

- delivery time
- economic duration
- maintenance
- stand-by facilities
- manufacturer support
- manufacturer position in market
- ?

1.3.2 Comparison choice of hardware

Following a systematic heading of qualifying machines with associated choice data, the comparison and choice procedure may be started. The following techniques may be applied

- comparison of individual factors
- comparison of combinations of factors
- general application per firm
- specific application per firm
- elimination of factors and machines

Comparison of individual factors

In theory this could be carried out as follows. For each choice factor it is determined what is the best machine, or even better - what is the order of preference, the latter with relation numbers added. Next, for each choice factor the weight within the total of all choice factors is determined and expressed in a relation number. Then, by multiplying the sequence numbers of the machines by the weight numbers of the factors the value of each machine per choice factor is determined. Finally, by adding the results the value of each machine is determined, following which the choice could be read.

Comparison of combinations of factors

The procedure described above appears to be not satisfactory in practice. One of the reasons for this is that some choice factors cannot be simply compared, as e.g. the working store (application efficiency of character-, byte- and word stores).

Another reason is that for each choi e factor within the total of all choice factors the weight may be differently determined for various machines (e.g. input-, processing- and output speed). Still another reason is that the value of many choice factors for each other is strongly influenced by the specific characteristics of the application and the firm.

The first problem may be solved, in principle, by combining the choice factors, as e.g. the combination of input-, processing and output speed into "through-put speed". In this case, per machine a relation number is determined for a number of different throughput possibilities (e.g. with the application of card, tape and disk). The formulas on which these relations numbers are based are often termed "mix" formulas. Some well-known formulas are the Gibson mix and the Gamm mix. The Gibson mix provides mix numbers for scientific as well as administrative applications (developed in the USA). The Gamm mix gives numbers for scientific applications only (developed by the Association for Applied Mathematics and Mathematics at Aachen).

Another possibility for obtaining combinations of factors which are easily handled in practice by combining individual choice factors is the prestation graph. These graphs, like the mix numbers, relate to a specific standard operation, but the prestation graph is more extensive. Also, for each operation more numbers are provided now, namely for a number of different standard configurations. By using lines instead of numbers variables may be drawn, e.g. the relation between the number of transactions and the number of records. An example of such a graph is file updating. On the vertical line the time is measured needed for updating 1,000 records, and horizontally the average number of transactions per record are mentioned. Per standard configuration a line is drawn, varying from 0 transaction/record to 1 transaction/record (for prestation graphs see e.g. Auerbach Standard EDP Reports).

General application per firm

With this technique a general business application is formed from all, or from a representative group of specific business applications. First of all a standard character is determined. This standard character indicates the relation between the number of characters and digits used, e.g. 60 characters and 40 digits. Then, the standard working package is compiled; e.g. the processing of a 1,000 record file, each record of which consists of 100 standard characters, the package consisting of:

- card to magnetic tape conversion (25% of all records)
- sorting (5%)
- file selection (100%)
- transactions (10%)
- calculations (2%)
- magnetic tape printout (0,25%)

Then, as with the mix number, for each of the operations mentioned the mix formula is determined, after which the throughput time can be determined for machines qualifying for choice. By adding the throughput times per operation, the total throughput time per machine per 1,000 records is obtained. With the aid of this data various curves may be drawn, as e.g. the number of standard operations to be carried out per 1,000 standard characters to be transferred, the number of standard characters per second to be transferred, the relation costs-performed, etc.

Specific applications per firm

Another technique is selecting one, or a very limited group small applications which are representative for the firm, and to design a system for those applications. Next, the manufacturers who are qualified for the choice are given the opportunity to write a programme for these systems. With the aid of a test set to be produced by the user a number of test operations are then carried out, via which it will appear what machines are meeting the specific requirements, and how much time they need for that purpose.

Elimination of factors and machines

With this technique all choice factors which do not play any part (or only a small part) in the concrete situation, are eliminated. This leaves only a number of factors which may be paid relatively more attention to. The remaining factors are assigned a serial number, indicating their weight. Then, the requirements which were formulated in stage 1.2.2 of the study (technical requirements for the greater part) are also assigned a serial number. On the strength of the latter list the machines are eliminated which fail to meet one or several of the most substantive requirements. Next a number of requirements are formulated, which should be made from the manufacturers. These e.g. include:

- specific minimum support in system development
- specific minimum stand-by facilities
- delivery before a specific date
- specific minimum portion of the market
- ?

On the strength of this list some more machines are eliminated. Finally, the remaining machines are assigned a note per factor, with the aid of the already limited factor list, via which note the sequence of the remaining machines is determined by adding the awarded notes.

Combined application of techniques

In practice, usually various techniques described above are applied. For as far as the elimination techniques may be applied this should always be preferred, since the often large quantities of work associated with the choice may so be reduced. The choice of the technique to be applied is further determined by:

- the availability time for the study
- the complexity and size of the firm to be automated
- the experience of the functionaries involved in the study
- choice criteria of a more subjective character (firm's policy, personnel relations, etc.)
- ?

1.2. STRUCTURE OF ORGANIZATION SYSTEM (PERSONNEL)

1.2.6 Structuring the personnel organization

The functions (system components) obtained during the analytical stage (1.1.2) are, in this stage, so structured opposite each other that the organization structure is obtained. Depending from the size of the firm a number of levels are distinguished within this structure. For instance (from top to bottom):

- whole firm
- divisions or main departments
- departments
- functions

During structuring specific organization principles will have to be taken into account, or they should be chosen from a number of alternatives. The most important are:

- number of superiors
- number of subordinates
- department structuring
- staff jobs.

Number of superiors

The theory of organization distinguishes between one-man management and management by several executives. The advantages with one-man management are:

- no contradictory instructions from superiors, forcing the subordinate to constantly face the problem of making a choice;
- no playing off of superiors against each other by the subordinate;
- ?

The advantages of management by several superiors are:

- the total expertness on a specific management level may be higher by dividing it over several executives;
- in specific situations the number of subordinates may be limited, e.g. when a number of management executives each wish to use the services of one and the same employee, with this employee carrying out the whole quantity of work (secretary, specialists, etc.);
- the geographic decentralization of specific functions, both disciplinary and functional management may be guaranteed (e.g. timekeepers at a plant, disciplinary management by the manager and functional management by the administrator)
- ?

In general it is desirable that each employee within the organization has only one superior. This provides what is called in the theory of organization: "uniformity of instruction".

Number of subordinates

The number of subordinates should be neither too large nor too small. In terms of organization, one has to take into account the "authority span". The disadvantages of a too large number are:

- the superior does not have enough time to supervise each one of his subordinates (individual support)
- the superior does not have enough time to supervise the total subordinate personnel (co-ordination)
- ?

The disadvantages of a too small number are:

- the superior has too much time, causing a loss of managing capacity
- the superior has too much time, resulting in insufficient delegation with all associated objections for subordinates (limitation of independence, unfolding and promotion)
- ?

Department structuring

When sub-dividing the firm into departments a distinction may be made into:

- product (product groups)
- position (geographically)
- function (type of work)
- ?

These three categories have the following advantages:

Product

- good knowledge of the product
- less need for attunement
- less need for communication
- less need for transportation
- fewer psychological objections
- ?

Position

- good knowledge of position (better relation with clients)
- same advantages as with Product
- ?

Function

- good knowledge of function (efficient job performance)
- possibility for application of bigger, i.e. more rational resources (e.g. computers)
- simple internal checking
- ?

With respect to the above it may be generally stated that the advantages of one category are, in principle, the disadvantages of another.

Staff jobs

The advantages of the functional organization is a good knowledge of the activities, often difficult to realize on the management level. The necessary knowledge with management is so varied, that a job assignment on the basis of such knowledge would lead to a too large degree of "cutting up" of the management. This problem may be solved by limiting the number of management executives, and have the specialist knowledge introduced by staff executives (specialists). The latter are assigned to management executives as advisors and they have no hierarchical authority. Examples of direction staff jobs are:

- organization
- personnel
- legal affairs
- public relations
- internal checking
- ?

Examples of department staff jobs:

- planning
- job preparation
- quality checking
- ?

1.2.7 Description of personnel functions

This description serves the purpose of recording the jobs in such a way, that everyone involved will clearly understand who is responsible for what. Furthermore the description will have to offer the possibility of deriving from it the demands to be made from the employee. In general the following elements should be included in the description:

- short description of function
- hierarchical position of function
- responsibilities, sub-divided per job
- authorities associated with the responsibilities
- relations:
  - superiors and subordinates
  - other functionaries
  - external contacts

1.2.8 Determining demands with respect to personnel

Designing the personnel organization also includes determining the demands the functionaries should be meeting. The most important categories of demand are:

General

- age (possibly age groups)
- sex (man/woman)
- talent (type indication)
- education (elementary, secondary or higher education)
- experience (specific industrial experience)
- ?

Specific

- talent (with respect to function and function environment)
- basic education (professional training, university)
- application education (training courses, etc.)
- basic experience (general professional experience)
- application experience (specific professional experience)
- ?

Demands to be made from personnel include not only the qualitative demands, but also quantitative ones. The latter are determined by calculating the times allowed for all operations to be carried out. For this purpose the following techniques may be used:

- estimating spent times
- time accounts
- multi-snapshots
- time studies
- standard times systems
- ?

The choice of the technique to be applied depends from:

- required degree of accuracy
- interest of those involved in the result
- attitude of those involved in the study
- practical possibilities
- available time for study
- frequency of operations
- number of variable factors
- costs of study
- ?

The allowed times which are determined are totalized per function, giving the total required time. Before deriving from this data the required number of personnel, the obtained time should first be increased by a percentage for the so-called unproductive times. This includes:-

- holidays
- illness
- personnel care
- ?

1.3 Choice of personnel to be appointed

On the strength of the demands mentioned sub 1.2.8 the candidates for the choice are determined and the choice is made by comparison.

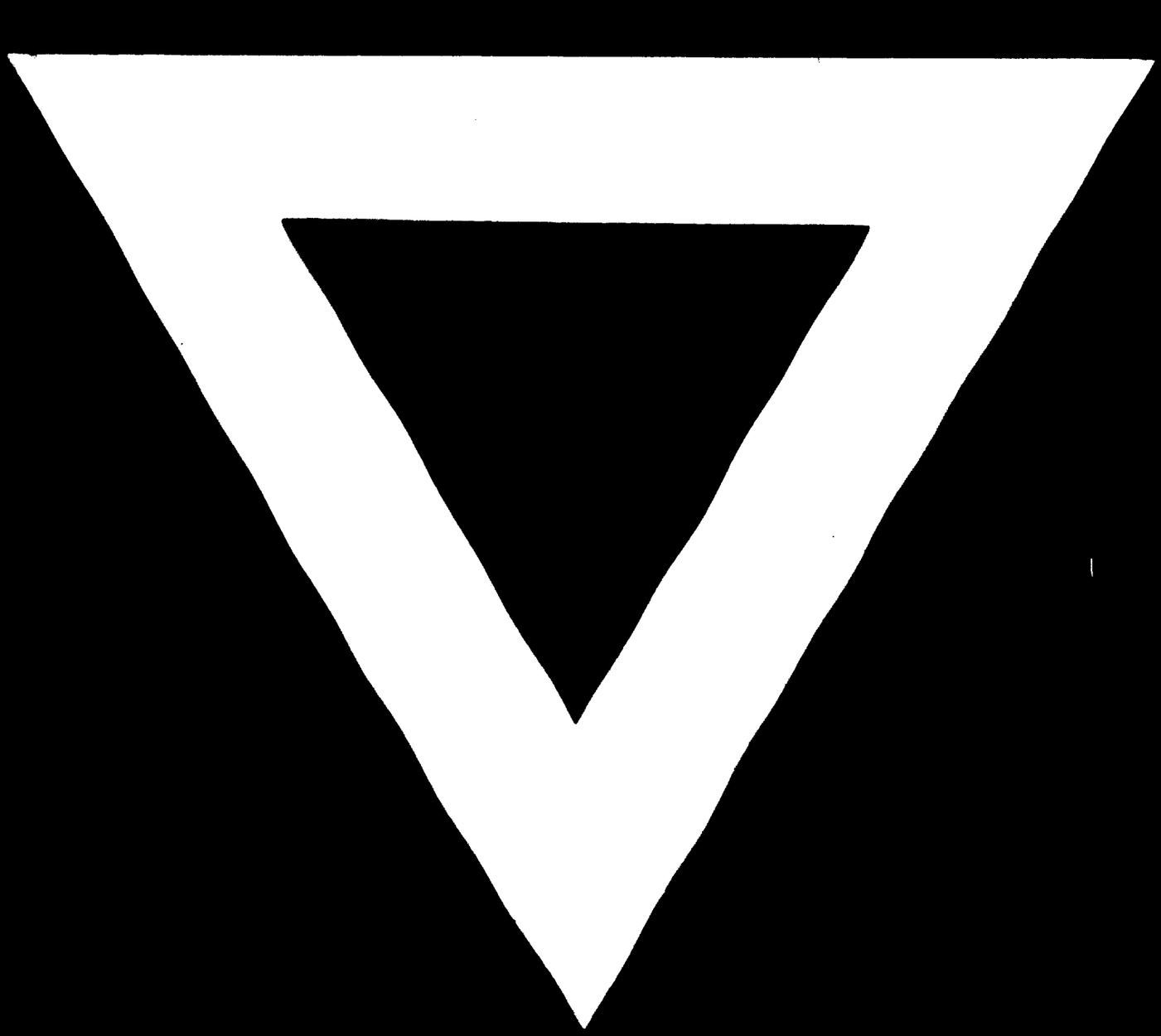
1.3.6 Determining and sectioning alternative candidates

After an internal/external recruitment campaign and the possible candidates have been collected, a first selection may be carried out. This selection is generally made on the basis of the submitted information (application letters and forms). Next, the remaining candidates are subdivided into sections in order of possible aptitude.

1.3.7 Comparison and choice of candidates

Following a systematic sectioning of the qualifying candidates with the associated choice data, the comparison and choice may be made; with the evaluation the following data/techniques may be applied:

- contents of application letter
- contents of application form
- graphologic report on application letter
- application talk
- psychological examination
- information from previous employers
- information from other references.



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