MASTER

Computer integrated manufacturing
one step further with system INFOFINISH

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Computer Integrated Manufacturing;

One step further with system INFOFINISH

Adapted version for readers not working at Rank Xerox

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Result of the Graduation Project at Rank Xerox in Venray.
Graduationperiod: 5 January 1987 until 30 november 1987

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Preface

With this report I finish my graduation project which I did at Rank Xerox in Venray in the period from Januari until November 1987. By fulfilling this graduation project I will become a Master in Mechanical Engineering at the Technical University of Eindhoven.
Rank Xerox in Venray (RXV) mainly produces copiers. I worked for the Manufacturing Engineering Department which supports the technical side of the copier-production.

Three phases must be distinguished in my graduation project; I have subdivided this report in three parts according to these three phases;
Part I contains a describtion of RXV and gives an overview of my graduation project, it may be read as one extended Preface for the other two parts; Part II contains the results of my first project in RXV; a survey on Computer Integrated Manufacturing. Part III contains the outcome my the second project: the design of information system INFOFINISH.
Every part can be read completely indepent from the other parts, they may be seen as seperate projects. Nevertheless there is a relation between part II and III: part III describes the INFOFINISH-project, which is an elaboration of one of the projects mentioned in Part II.

To me, my period at RXV was joyful and very engaging and interesting. Firstly, the main subject of my project, Computer Integrated Manufacturing is quite new nowadays. To my opinion it promises a lot for the future. Therefore this subject attracted (and still attracts) me and it was a challenge to work on this 'hot item' during my graduation project.
Secondly, RXV is a modern production plant and part of a multinational organisation. I could see modern production techniques working and also find out something more about the difficulties related with these newest techniques. I could also taste something of the political aspects which are playing a role in a multinational organisation like Rank Xerox.
Thirdly, it was sometimes difficult to deal with a scientific environment on the one hand, and a company, strongly directed to the buyers-market, on the other hand. Now, when I look back, I think this improved the quality of my graduation project because I was constantly forced to look from two different angles.

Working at RXV was quite comfortable:as it is a modern plant, I was surrounded by all kinds of userfriendly Word Processors. Unfortunately, not even these Word Processors offered me a suitable solution for the usage of the words 'man' or 'woman' and 'he'or 'she'. In order not to make this report difficult to read, I have chosen to only use the male indications of a person. So only for that reason.

At this place I would like to say a special 'dankjewel' to those people who helped me on all kinds of subjects during my work at RXV:
* My coaches at RXV , Mr Van Ophuizen and Mr Brandsma for the engaging graduation period.
* My coaches at the Technical University of Eindhoven, Mr Doorschot and Mr Mikkers for the given advice and help.
* Mr Korlaar, from the Technical University of Eindhoven, who supported me with his knowledge about information systems.
* A whole serie of people at Rank Xerox whose help, supporting or chats were indispensible. Unfortunately it is impossible to mention all their names here.
* Mr and Mrs Van Marle for checking my English.
* Marcel, my friend, for the moral support and checking activities.

Mark Mathijssen,
Venray, 1 November 1987.

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Part III: INFORMATION SYSTEM INFOFINISH

Contents

Summary

This report consists of 3 parts which can be read independently from each other;

Part I: 'Introduction'

The Rank Xerox plant in Venray mainly produces copiers. I worked for the Manufacturing Engineering Department which supports the technical side of the copier production. My work was related with Compter Integrated Manufacturing, see part II and part III.

Part II: 'Computer Integrated Manufacturing at Rank Xerox in Venray'

The objectives of the survey on Computer Integrated Manufacturing (C.I.M.) were:
1. To establish a model for Computer Integrated Manufacturing.
2. To define and to describe shortly projects related with Computer Integrated Manufacturing.

The term which explains and defines CIM exactly is C.A.P.D.P.: Computer Aided Product Delivery Process. The Product Delivery Process is the whole process of design, production, launching and maintanance activities related with the delivery of a product. In order to create a model for CIM the Product Delivery System is analysed which resulted in structuring the Product Delivery Process into 4 functions; Design, Process Planning, Logistics and Manufacturting. These functions have relations to each other which find expression in sending and receiving infromation to and from each other. I assume that the information streams which are shown in figure S-1 are the minimum information streams needed for a successful PDP.

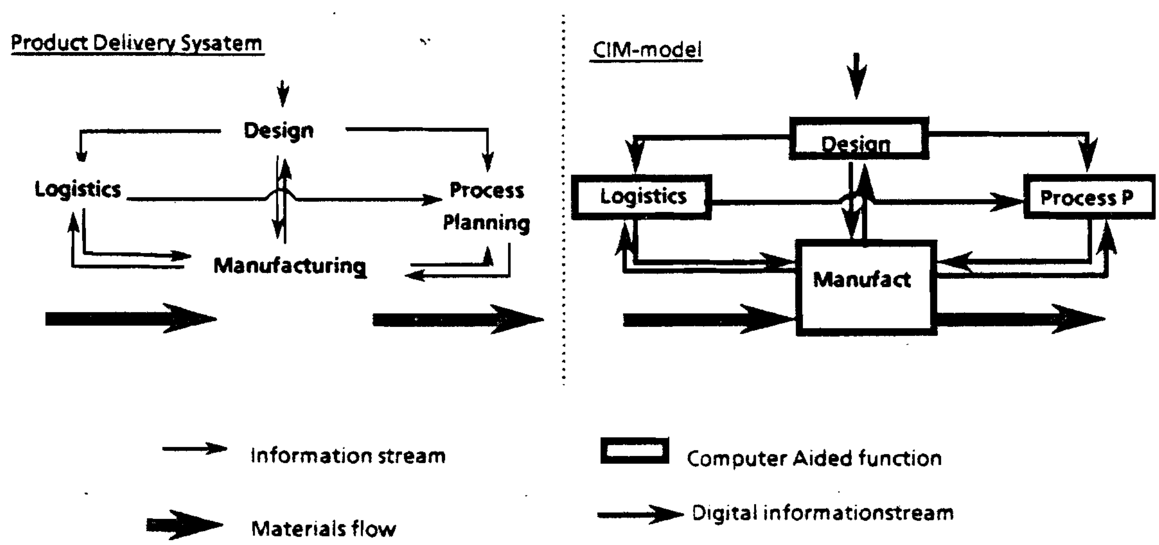


Figure S-1: Product Delivery Process and CIM-model

The CIM-model which I propose to use as the basis for the CIM- strategy of RXV results out of figure S-1 (left figure) and is also shown in figure S-1 (right figure). This model structures and visualises a CIM-system.
I define the Complete CIM-System as a CIM-system in which:

- the work which is done in the different functions of the Product Delivery Process is aided by computer systems;
- the information streams between these functions are provided by linkages between computer systems.

The "Complete CIM-System" can be realised out of the current CIM- system in Rank Xerox by fulfilling the projects mentioned in table below.

	Return on investments	Flexibility-improvement	Throughput-time decrease	Quality improvement
Project 1: CAD-system in RXV	4 years	Yes. As a result of the through-puttime decrease.	Yes. Due faster information-transport, faster drawing processing	?
Project 2: Systems to support Design For Production	consider systems on their own	Yes. Design is better attuned to Manufacturing	Yes. Better availibility of information and a better tuning of the design to the production.	Yes. Design is better attuned to Manufacturing
Project 3: Realising CAPP/CAM	consider systems on their own	Yes	Yes	?

Part II ends with two recommandations:

1. Use the proposed CIM-model for linking and structuring actions which are taken in accordance with CIM.
2. Perform feasibility studies on the proposed CIM-projects.

Part III: Informationsystem 'INFOFINISH'

My second task was to start the project which ends up in an: "Informationsystem with information about the finishing processes for usage by the product designers. This system must help the designers to attune his product to the finishing processes. It is based on computers."
(This project will realise a system which is mentioned in part II as "an information system to support Design For Production)
The objectives of this project are:

1. To reduce costs during the production and maintenance phase.
2. To decrease the total throughput time in the Product Delivery Process.
3. To improve the quality of the product.
4. To create efficient feedback possibilities.
5. To gain a better insight in problems which will occur when creating these kinds of systems.

I worked on this project according to the system development strategy "SDM" and fulfilled the Definition, the Functional Design and the Technical Design phase.
I have designed the informationsystem "INFOFINISH" in detail. This design provides a frame which gives opportunities to realise the objectives of the project. I recommend RXV:

- to continue the project which is started. This means programming, testing and implementing "INFOFINISH". It will take approximately 7 months to finish this project.
- implement the information systemon the IBM-mainframe in England or U.S.
- arrange involvement of the system user in this project.

Glossary

C.A.D.:	Computer Aided Design
C.A.L.:	Computer Aided Logistics
C.A.M.:	Computer Aided Manufacturing
C.A.P.P.:	Computer Aided Process Planning
CCM:	Central Commodity Management.
C.I.M.:	Computer Integrated Manufacturing (The situation in which "the manufacturing of a product" is aided by a computer)
CIM-system:	A CIM-system is a system of computers which supports the activities which are related with the delivery of a product. A CIM-system realises C.I.M.
CRLV:	Change Request Live Variance.
D.F.P.:	Design For Production
EM&SD:	European Manufacturing & Supply Division.
File:	Collection of data with a certain relation between them.
Finishing specification:	Specification of the characteristics of a product surface.
Finishing process:	Manufacturing process which processes a product in order to give it better mechanical, esthetical or corrosionresistance properties.
Information:	Reduction in uncertainty of a person as a result of his/her interpretation of given data.
Information system:	System which processes data in order to create relevant and useful information for the user of the system.
Intergraph:	Trade mark of a CAD-system. In general Xerox uses these CAD-systems to design its products.
M.A.P.:	Manufacturing Automation Protocoll
MRT(-team):	Manufacturing Resource Team. Team of engineers which performs the link between the designers and the manufacturing plants (e.g. suppliers). They consider the manufacturing possiblitities and requirements. They also negotiate with the suppliers about prices and deliverings dates.
P.D.P.:	Product Delivery Process
RBG:	Reprographic Business Unit.
RX:	Rank Xerox

RXV: Rank Xerox Venray.

WGC: Wellyngarden City

Xerox Finishing Team: A Xerox Team which evaluates finishing - suplliers and finishing processes.

XCN: Xerox Change Notice

Part I:

Introduction

Contents part I:

Chapter I: INTRODUCTION

With this first part of the report I will give the reader information about Rank Xerox in Venray (RXV) and about my work at RXV. The objective of this part is to give the reader background information for the other two parts of this report.
Chapter 2 of Part I gives information about Xerox and Rank Xerox' production plant in Venray (RXV).
Chapter 3 of this report gives an overview of my work at RXV. It describes shortly: the development of my task in RXV, the different periods in which my staying at RXV can be divided and the way I approached the tasks I was given.

CHAPTER II: RANK XEROX VENRAY

2.1. General information

Xerox and its History

In 1938 the American Chester F.Carlson invented the Electrophotography, which was later called the Xerography. Xerography literally means 'writing dry' In the beginning Carlson had some difficulties with getting the attention of the business community on his invention until he met Joseph Wilson, who was a director of The Haloid Company,a little company in light-sensitive paper . In 1948 the first copier was launched on the market. The Haloid Company, later renamed to the Xerox company, started producing copiers and with success.
In order to be able to cover the copier market worldwide the Xerox Corporation created in 1956 together with the English Rank Organisation a joint venture called Rank Xerox. Rank Xerox is represented in Japan and 8 other Asian countries by means of a joint venture with the Fuji Photo Film Company: Fuji Xerox.
The Xerox products are sold in more then 80 countries. Every country has its own sales and service organisation.

Right now Xerox is a worldwide producer of complete Office Automation Systems. It delivers a broad assortment of micro- computers, electronic typewriters, copiers, wordprocessors, intelligent workstations, laserprinters, facsimile apparatus, drawing officesystems and local area networks.
The Rank Xerox plant in Venray produces copiers of the mid volume class (which can make 25 to 60 copies per minute) and therefore I will confine myself in this report to the Mid Volume Business Unit of the Xerox Reprographic Group.

Production plants of the Reprographic Business Group are established in the United States, England, France, Spain, The Netherlands, Canada, Mexico, Brasil, India and Japan. The total Xerox corporations consist of approximately 104.000 employees of which 40.000 work for Rank Xerox joint venture.
Xerox has two research - and development centres; one in Webster (U.S.) and one in Welwyn Garden City near London, England.

The Xerox Product Delivery System

Xerox divided the life cycle of a copier into 7 phases; alltogether these phases are called the Product Delivery Process (PDP). The PDP is a guideline for the ongoing cycle of activities required for the delivery of a new product. (lit.[1])

The 7 phases in a copier life are:
1. Pre concept phase
2. Concept phase
3. Design phase
4. Development phase
5. Production phase
6. Launch phase
7. Maintenance phase

Each phase is followed by a "Checkpoint Review". Hereby decisions are made whether to proceed to the next phase of a program or not. Also assessments of making and meeting quality, costs and delivery commitments to the corporation and the operating companies is evaluated.

The PDP provides a uniform framework for standardising product development and delivery activities throughout the Reprographic Business Group. With this program it is possible to build upon accomplishments of previous product programs. It is the standard on which all the programs are managed.

Suppliers

Xerox (and also RXV) knows only 500 suppliers for all its production plants all over the world. All the production plants have the same supplier for the same part or assembly. The main advantage of a low amount of suppliers is that Xerox has a better influence on the supplier; higher requirements and also education of the supplier are possible.
This better relationship also gives the supplier the possibility to give specialistic information to the designers whose product design has to be realised by these suppliers.

The suppliers of Rank Xerox Venray alltogether take care of a daily incoming material flow of 1,000 pallets withan annual value of 400 Million Dollars

2.2. Rank Xerox in Venray

Rank Xerox Venray, part of the Rank Xerox joint venture

In the Netherlands approximately 3.000 employees work for Rank Xerox; 850 employees work for the Marketing and Sales department which has its main office in Amsterdam and 2100 employees work at the establishment in Venray.

Rank Xerox has a production plant in Venray since 1965. In Venray there are two different organisations of the Rank Xerox joint venture; Rank Xerox Manufacturing The Netherlands and the European Logistics Centre (ELC). The ELC is the central distribution centre for copiers and spares for whole Europe; in this report I will not consider the ELC.

The annual turn over of the Manufacturing plant amounts to more than MDF 500. The products are made for Europe, the Middle East, Africa and North - and South America.

The RXV plant covers an area of 380,000 m2; buildings are build upon 110,000 m2. The floorsurface for production amounts to 41,600 m2 and for storage 34,000 m2 (12,000 m2 for assembly storage and 22,000 m2 for spares storage).

Production process

Since 1981 RXV mainly produces the "1045 family" copiers. See paragraph 2.3. 'Products'.
For three years now Venray controls its incoming material flow with an automatic material control system called AMACS. This system:

- eliminated conventional storage through "Just -In-Time"delivery;
- enabled automatic material handling throughout receival to production line replenishment by reversing the excisting MRP driven "push" system into a "pull" mode in which the material delivery is initiated by the assembly workers

Nowadays the throughputtime of copiers amounts to 6 to 8 hours, this is at least 6 times shorter than before the AMACS-system was introduced. Many parts to be assembled are on

their way in trucks. 60 % of the Work In Progress is directly used, 25 % is stored in the warehouse and 15 % is stored near the workstations, ready to be used. The ultimate product is sent directly to the European Logistic Centre.
The internal transport is carried out by means of conveyors, Automatic Guided Vehicles (AGV's), Automatic Stores Cranes and conventional Forktrucks.
Fore more information about the Just In Time Material Flow Automation see literature [2].

The organisation

The Reprographic Business Group of Xerox is organised in a matrix structure (see figure I-1); three Business Units divided in a Design group, a Manufacturing group and a Marketing and Sales group.

	Low Volume Business Unit	Mid Volume Business Unit	High Volume Business Unit
Design			
Manufacturing		EM&SD (e.g. Venray)	
Marketing & Sales			

Figure I-1: The organisation of the Xerox Reprographic Business Unit

RXV belongs to the Mid Volume Business Unit and mainly is under the direction of the European Manufacturing & Supply Division (EM&SD).

The RXV organisation is divided into 4 groups:
- Manufacturing operations: For control of the production
- Materials and Supply: For control of the incoming products and their suppliers
- Finance and quality control: For control of the financial affairs and production quality.
- Social affairs: For personal affairs, canteen organisation etc.

See for the organisation-scheme figure I-2.

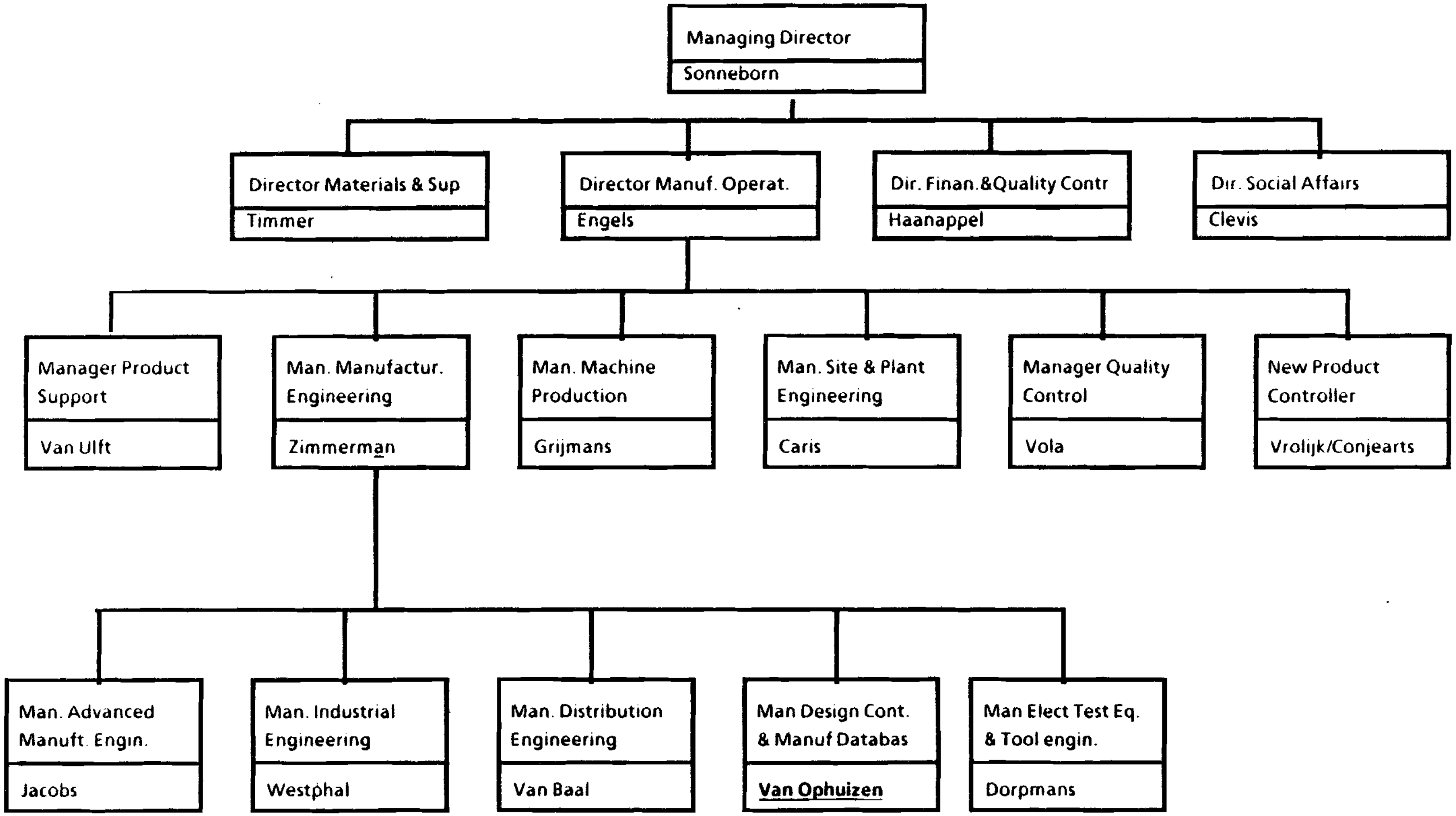


Figure I-2: Organisation scheme of Rank Xerox Venray

The products

RXV mainly performs the following production activities:

- assemblying copiers for the mid-volume Copier Business Group; 60.000 copiers a year.
- assemblying printed wiring boards and other electronical apparatus; 8000 units a year.
- producing toner (ink powder which is used by the copiers).
- organic and anorganic finishing of parts; iron phosphating, zinc phospating, electrocoating, robot spraying, hand spraying

In this report I will only consider the production of the copiers. Mainly since 1982 Venray produces the '1045-family copiers' . See tabel 1. Other plants which also produce 1045-family copiers are established in Lille and Mitcheldean.

Table 1: this report-version does not contain table 1

The product designs for the copiers to be assembled mainly come from Welwyn Garden City (England).

A copier is built up out of a central processor (the basic copy-unit) with some in- or output devices connected to it such as a high capacity feeder, a sorter or a stitcher.
A processor unit consists of approximately 1500 different kinds of "buy level parts". (A buy-level part is defined as a part or assembly which is transported to the assembly-line separately from the other ones).

Commonality between two different types of copiers is represented when the same copier family is concerned; When a designer knows that he did design the same kind of part in the past he can take the drawing of this part as a basis for the drawing he has to make. Because there are specialist-designers for special kinds of assemblies for copier-types within a family one can reach a high commonality between these copier- types.
There is NO commonality, geometrical nor functional between copiers of different families.

Chapter III: MY WORK AT RXV: PROBLEM DEVELOPMENT AND APPROACH

I have fulfilled my graduationproject by working on different tasks assigned by RXV in the period 5 January 1987 till 30 November 1987.
I worked at the Manufacturing Engineering Department which is a part of the Manufacturing Operations Group of the Mid Volume Business Unit. Roughly speaking, this department has to take care of the developments and the control of the production machines and their usage; e.g. activities such as industrial engineering, distribution engineering, improving production methods, test equipment, tool design and tool control. My two coaches were Mr Van Ophuizen and Mr Brandsma. Mr Van Ophuizen. is a manager of two sub-groups of the Manufacturing Engineering department: "Industrial Engineering" and "Design Control & Manufacturing Database". Mr Brandsma is Finishing Engineer at RXV.

The graduation project lasted 10 months. These 10 months can be devided into three periodes (see also figure 3):

5 January till 15 Februari 1987:	Start of my job; General orientation on my task and the company;
15 Februari till 30 April 1987:	Second period: Survey on Computer Integrated Manufacturing (CIM) and CIM-related projects which can be supported by RXV (paragraph 3.2.);
1 May till 30 November 1987:	Third period: Working out one CIM related project.(paragraph 3.3.).

(with 1 month of holiday included)

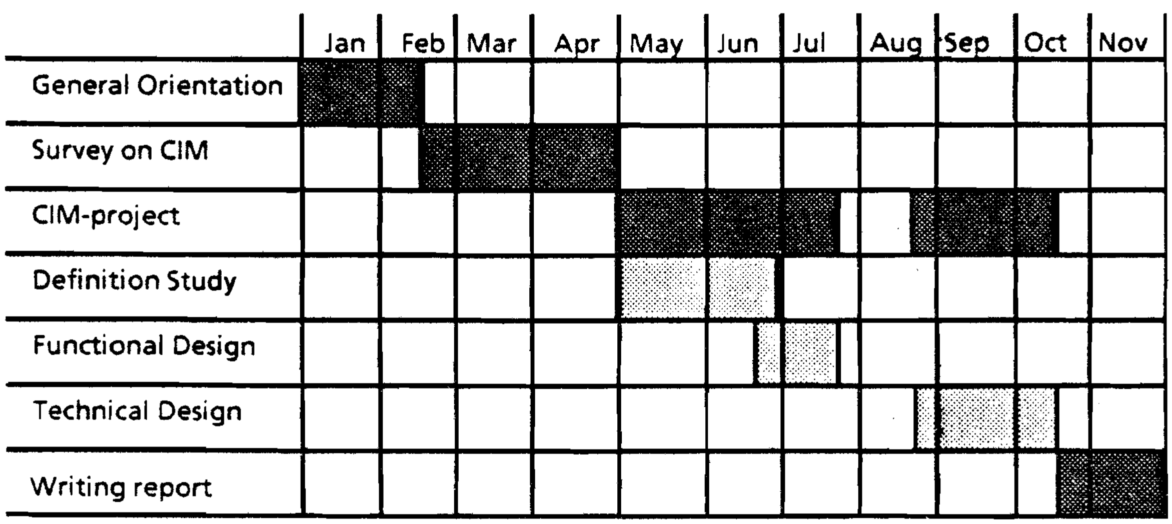


Figure 3: Overview of my work at RXV in 1987

After the general orientation it occurd that a more extensive survey of the possibilities of CAD in relation with other production related activities was useful.(see Introduction of part

II). Therefore I did a survey on C.I.M. which ended up in an essay called "Computer Integrated Manufacturing at Rank Xerox Venray".(lit.[3])

The objectives of this report were:
1. To establish a structured frame for standardasing CIM-projects in Rank Xerox Venray.
2. To define and to describe shortly CIM-projects which need to be fulfilled in order to get a basis for a CIM-system in Rank Xerox Venray.

This report was the introduction to the next period in my work at RXV: from May until November 1987 I started the project of which the result is mentioned in the report "CIM at RXV" as: "Information systems to support 'Design For Production'"

For this project I made a project planning in which I made use of the " System Development Methodology" (SDM) which is designed especially for developing information systems. (lit.[4]). This planning is shown in appendix 2.

SDM distinguishes 7 phases in developing an information system:
1. Definition Study
2. Functional Design
3. Technical Design
4. Programming
5. Testing
6. Conversion
7. System usage and Maintenance

Every phase is closed with a report which needed the agreement of all parties involved.

<u>ad 1; Definition Study</u>

The objective of the Definition Study is to determine whether the development of a new system is justified and if so, how this should be done. One will get a better insight in the problems wich will occur and the (dis)advantages of such a system.

I spent most of the months May and June on:
- defining the objectives to be reached with the mentioned project
- analysing the current situation
- developing and analysing alternative solutions
- exactly defining the project result
- defining the ultimate user of the project result
- defining the requirements for success of the project result
- determining the project strategy and planning
- analysing whether the chosen project strategy could result in solving the mentioned problem
- enlarging my knowledge about information systems and the design proces in Rank Xerox.

The most important thing which has to be mentioned here is that the definition of the project result changed from ""Information systems to support 'Design For Production'" to: "An information system with information about the finishing processes which simplifies the designers' attuning of his product designs to the finishing processes. This information system is based on computers."
See appendix 1 for the planning which is set up in the Definition study for this project.

In the end of June a concept of the report of the Definition study was ready; a total agreement about this report with parties involved was reached 17 August (lit 5).

ad 2: Functional design.

During the Functional Design phase a functional design of the whole information system is set up. A functional design is made out of:

- specifications of the functions which will be performed by the new system
- a sub-deviding of the system in subsystems and a description of the interfaces in between
- a determination of the input and output of these subsystems and a description of the processes in these sub-systems
- a description of the environment in which the system will have to operate
- the design of the data structure
- a specification of the required hard - and software

Although a total agreement about the Definition Study Report was not reached before the 17th of August I could start with the Functional Design Phase, from the end of June. I finished the Functional Design Phase with a report issued on 24 Juli (lit. 6)

ad 3; Technical design.

The Technical Design describes HOW the informationsystem should work, HOW the different sub-systems can be realised and also describes the physical organisation and structure of the data files.
At the end of september I finished this third phase of the project.
I have not issued a report which contains the results of the Technical Design. These results are put in part III of this report.

Part III of this report contains all the information needed for the continuation of the project. So it is a togetherness of information already published (at the end of the phases Definition Study or Functional Design) and of information which belongs to the Technical Design.

The phases Programming, Testing, Conversion and System Usage and Maintenance have not yet been executed. Management has to decide first whether to continue the project or not.

PART II

COMPUTER INTEGRATED MANUFACTURING

at RANK XEROX VENRAY

CONTENTS

Chapter I: INTRODUCTION

A company has to meet other performance criteria than those used in the past. This is mainly caused by a movement in the market from a seller's market to a buyer's market resulting in the following needs for the company:
- shorter product life-time;
- higher diversity in products;
- international competitive market;
- higher quality requirements;
- miniaturisation of products.

These new needs are the cause of some technological trends in the production like:
1. Dramatic decrease of parts to be assembled.
2. Strong decrease of assembly time.
3. Increasing importance of design.
4. Increased influence of software.

The main trend is that the greatest value added to the product in the cost build-up of a product moves from 'assembling products' to the 'production of parts or sub-assemblies'. Taking all these thoughts in account one has to acknowledge that the technical knowledge in a company is getting more and more important. Key concepts for the future will therefore be:

1. Exact forecasting of the production and reproduction of the used technical processes.
2. Effective and structured links between the different functions inside a company in order to receive a totally controlled and integrated structure.

These key concepts for the future are the main reasons for considering Computer Integrated Manufacturing (CIM) nowadays.
Computer Integrated Manufacturing stands for the usage of the computer within the Product Delivery Process (PDP) in the most general way;.whether it is for support of the activities or the linkage between the activities which have to be carried out in the PDP.
Other reasons for considering CIM are the increased possibilities of the computer as a result of better, faster and cheaper computer hard- and software.

Why Rank Xerox Venray can contribute very well in Xerox-C.I.M-actions.

To my opinion RXV can add a valuable contribution to Computer Integrated Manufacturing in Xerox because of two reasons:

First of all, being a manufacturing plant RXV posesses the technical knowledge. As shown above, this technical knowledge will be of increasing importance in the companies of tomorrow. It will become important for a designer to have all necessary information at his disposal in order to create an optimal design e.g. a minimum impact on material and material related costs. Being a production plant RXV can take care of this task and give the manufacturing input needed for an efficient and economical design.
This point gets the more important when we see that 80 % of the cost build-up of an average copier is made up out of material costs. So the best sources for costreductions are laying in the reductions of the materialcosts. This starts with a design which is fully attuned to the production.

Secondly, in RXV, CIM has reached a high level in Computer Aided Logistics, Computer Aided Manufacturing and in the link between Logistics and Manufacturing; a fully automated manufacturing planning and control system and fully automated internal materials handling are present (lit[2]).
This experience of integrating different functions with the aid of the computer is important for further developments in CIM.

The reasons for performing a survey on Computer Integrated Manufacturing originates from the general survey carried out at the start at my work at Rank Xerox Venray;
Firstly, inside the company there appeared to be different ways of looking at and sub-deviding CIM. It may be clear that this 'confusion of tongues' does not have a positive impact on the success of projects related with CIM.
Secondly, it seemed that one considers the different CIM-projects, which are being carried out, independently from each other. CIM-projects, like realising a CAD-system in Venray, working out the CAM-system in Venray or the 'SICAM'-project, are linked up with each other in a principal way and therefore could support each others' success.

As you know, the success of projects which are related to CIM does not rely on the projects themselves only but also on other subjects such as linkage possibilities with other sytems and the implementation strategy.

Objectives

The two objectives of this survey are:

1. To establish a model for Computer Integrated Manufacturing which can be used as the basis for the CIM-strategy of Rank Xerox Venray. A CIM-model gives the possibility to visualise clearly the relations between actions which are taken in accordance with CIM. The actions are linked and structured and in this way they can support each others' success.

2. To define and to describe shortly CIM-projects which need to be fulfilled in order to achieve the basis for a CIM-system in Rank Xerox.

In chapter 2 Computer Intergated Manufacturing is defined and analysed. This results in the CIM-model which I propose to use as a basis for the CIM-strategy of RXV. In chapter 2 I will also define the 'Complete CIM-system'. This Complete CIM-System is established, shortly speaking, when all the parts of the CIM-model are realised.
Chapter 3 describes the differences between the CIM-system in Rank Xerox and the Complete CIM-System.
Chapter 4 describes which actions must be taken in order to realise this Complete CIM-system in Rank Xerox.
Chapter 5 evaluates the results and gives recommendations for further actions to be taken in accordance with CIM.

Chapter 2: COMPUTER INTEGRATED MANUFACTURING; ANALYSIS

2.1. CIM-system; the definition

It is more useful to consider a CIM-system rather than CIM because CIM, Computer Integrated Manufacturing, is the situation in which the "Manufacturing of a product" is aided by computers. The 'aiding' is not interesting to describe; more interesting is WHAT is aided and HOW. Therefore we must consider the CIM-system which realises CIM.

A CIM-system is a system of computers which supports activities which are related with the delivery of a product.

A better term for Computer Integrated Manufacturing would be: Computer Aided Product Delivery Process, C.A.P.D.P, because this term exactly convers the meaning of CIM. Computer Integrated Manufacturing (C.I.M.) is present in a company when activities, which are carried out in the Product Delivery Process (PDP), are supported by a computer.

Not only the integration of the computer in the Product Delivery Process (PDP) is important, a CIM-strategy should also consider the integrations of the PDP-activities themselves.This is related with the possibility of a computer to transmiss and to process information very fast. It is important to make use of this possibility if one wants to receive the best results of the investments in computer hard- and software.

Now we can understand more why the term CIM is used; the term CIM encloses a word which is essential in the CIM-philosophy namely "integration".

The PDP encolses the whole process of design, development, production, launching and maintenance activities related to the delivery of a product. (see part I, paragraph 2.1. and [lit.1]).
So according to the defenition above C.I.M. does not include marketing operations . The reasons for this restriction are:

- the PDP describes the basic central operations needed for the delivery of a product. To mine oppinion this is also what the term C.I.M. encloses.
- marketing is fundamentaly different from the activities descriped by the PDP; it is not necessaraly related with the PDP operations.
- RXV is a member of the European Manufacturing & Supply Devision (EMSD) and fulfills the manufacturing operations for the Mid Volume copier Business Unit. (MBU). Therefore the other operations are not really interesting for RXV.

2.2. Analysing the Product Delivery Process

In order to set up a model for a CIM-system, which is done in paragraph 2.3., we have to analyse the PDP. There are many ways to distinguish and to define the different functions which are carried out in the PDP, and the way it is done is strongly related to the purpose of the distinction. The more areas you define the more accurate the resulting model will be. But, the more areas you define, the more relations you get and the more confusing the model will be. One has to keep in mind that a model is a simplified description of reality from a certain point of view, used for a certain purpose. Therefore, when setting up a

model, one has to search for an optimum between the accuracy and the clarity of the model.
I have chosen to subdivide the PDP into four different functions namely :

1. **Design**
   Covering product design and product development.

2. **Process planning**
   This area covers all the activities related to process planning; mainly providing workinstructions for the manufacturing area.

3. **Manufacturing**
   Covering the physical production of the product, assembly or part (including physical transportation of the materails/parts/products).

4. **Logistics.**
   Covering the control of the totally internal and external materials flow . The physical distribution of the materials is not part of Logistics but is covered by CAM Manufacturing. See paragraph2.4.3.

These functions have different relations to each others which find expression in sending and receiving information from and to each others.

These functions have mutual relations. These relations find expression in sharing information;

Design needs information from:
- Manufacturing;
  Information about the possibilities and requirements of the production.
- Customer, market;
  Information about the requirements of the customer

Logistics needs information from:
- Design ;
  This is mainly information about the products which will have to be produced by Manufacturing. These are not necessarely drawings but e.g. productconfiguration, figures about amounts of materials or about the processes to be used.
- Manufacturing;
  Information about the materials used or needed by the production and specifications about present or possible processes or handlings.

Manufacturing needs information from:
- Design;
  Information about products to be produced including drawings.
- Logistics;
  Orders and planning for Manufacturing about what to do and when.
- Process Planning;
  Instructions and guidelines for the production about how to produce certain products, assemblies or parts.

Process Planning needs information from:
- Design;
  This is also information about the products which have to be produced. Mainly product information like drawings and product configurations.
- From Manufacturing;

Information about the possibilities and requirements of the production.
- From Logistics;
  Information about the orders and planning which are sent to Manufacturing.

I assume that these information streams are the minimum of information streams which are required for realising a successful PDP. A successful PDP is a PDP which delivers a product:
- against the lowest costs
- with the required quality
- with shortest throughputtime
- with great flexibility in product-mix and volumes

Figure II-1 visualises these different activities and their relations to each others.

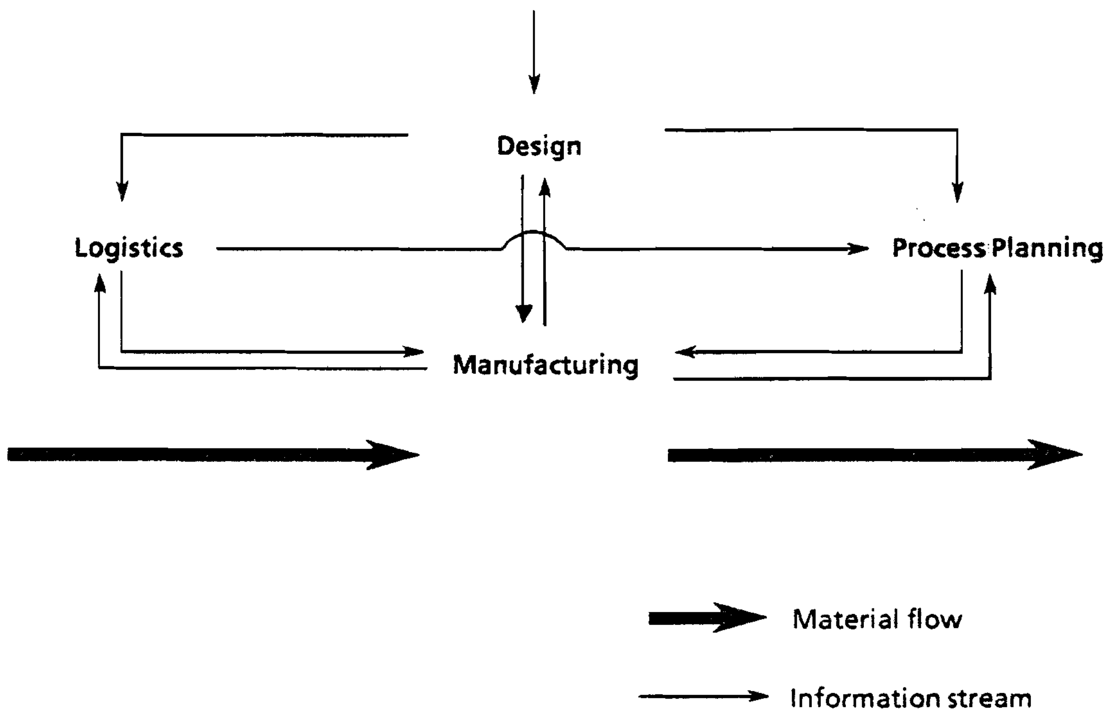


Figure II-1: The functions in the PDP and their relations

2.3. CIM-model

The CIM-model which I propose to use as the basis for the CIM-strategy of RXV results out of figure II-1 and it is shown in figure II-2..

In figure II-2 the four different functions in the PDP are surrounded by a rectangle which indicates that this function is computer aided by a computer system (C.A.).

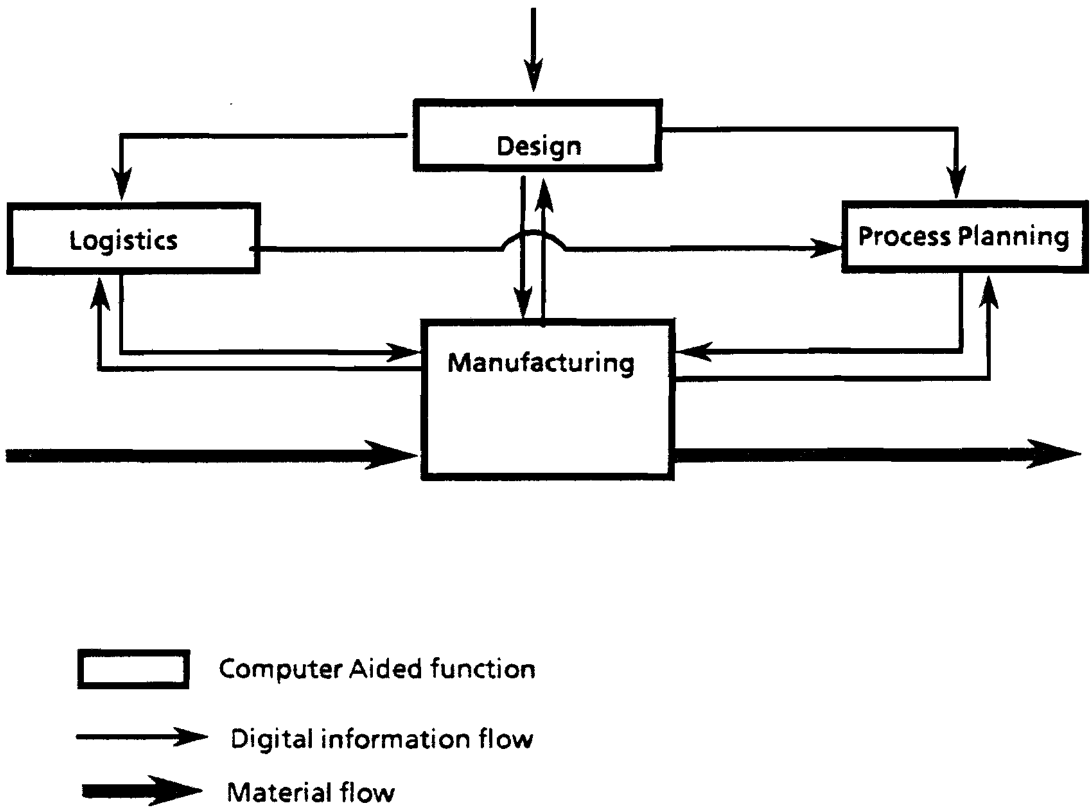


Figure II-2: CIM-model

The information streams are indicated with a thicker line than in figure II-1 which indicates that these information streams are "digitised information streams"; they are now provided by the linkages between the computers in the different PDP-functions.
These digitised information streams between the PDP-functions contain the same information as mentioned in paragraph 2.2.

This CIM-model structures and visualises a CIM-system.

<u>Complete CIM-system:</u>

I define the Complete CIM-System as a CIM-system in which:

- the work which is done in the different functions of the Product Delivery Process is aided by computer systems;
- the information streams between these functions are provided by linkages between computer systems.

The use of the proposed CIM-model doesn't imply that the Complete CIM-System has to be realised completely; no, still the development of any system which will be a part of the CIM-system has to be considered on its own. The use of this CIM-model only provides linking and structuring of the different CIM-projects. And that is what is important in setting up a CIM-strategy.
In chapter 3 I will compare this Complete CIM-system with the CIM-system in Rank Xerox.

We can structure the computer systems which are used in a CIM-system in the same way as we did with the PDP-functions This results in the following division of computer systems used in a CIM-system:

- Computer Aided Design-systems (CAD-systems)
- Computer Aided Process Planning-systems (CAPP-systems)
- Computer Aided Logistics-systems (CAL-systems)
- Computer Aided Manufacturing-systems (CAM-systems)

In the next paragraph these parts of a CIM-system, CAD, CAL, CAPP and CAM, are described.

2.4. Parts of a CIM-system

2.4.1. CAD-system

In the CAD-area we must again distinguish sub-areas for the same reason as we splitted up CIM. In this paragraph I will describe the way prof. Doorschot structures CAD-systems, lit[9]. In order to describe the different CAD-areas clearly Doorschot goes "back to base" and consider the structure and relations between product, production and production machines; see figure II-3.

A product can be splitted up successively in major assemblies, assemblies, standard parts and specific parts. The standard parts are mainly taken out of the stock. The specific parts are mainly made by processing machines. Professional parts or parts of which a small number is required can be made by NC- machines. The assembly of the different parts can be done by assembly machines.
Both, the processing machines and the assembly machines have to be manufactured. Therefore we can split up these machines in the same way as "the product" into major assemblies, assemblies, standard parts and specific parts. Generally the specific parts from 'machines' are more "NC-made" than the specific parts of 'products' because of the lower amounts of parts and the more professional geometry.

Keeping this overal figure in mind, we can distinguish 6 CAD-areas in figure II-3. This is done in figures II-4a and II-4b.

<u>CAD-area A</u>

In this area we see the splitting up of a product into function groups, sub-assemblies, standard parts and specific parts. CAD area A covers the design of the ultimate product.
Examples of CAD applications for this area are:

- geometric modeling;
- FEM;
- configurations management;
- libraries of already designed products;
- libraries with standard parts, functions and tools;
- libraries with design rules andproduction requirements.

<u>CAD-area B:</u>

The specific parts in a product lead to tools, moulds and process machines. The highest precision is needed to produce these machines. CAD-area B covers the design and development of these machines

Relations between product, production and productionmachines

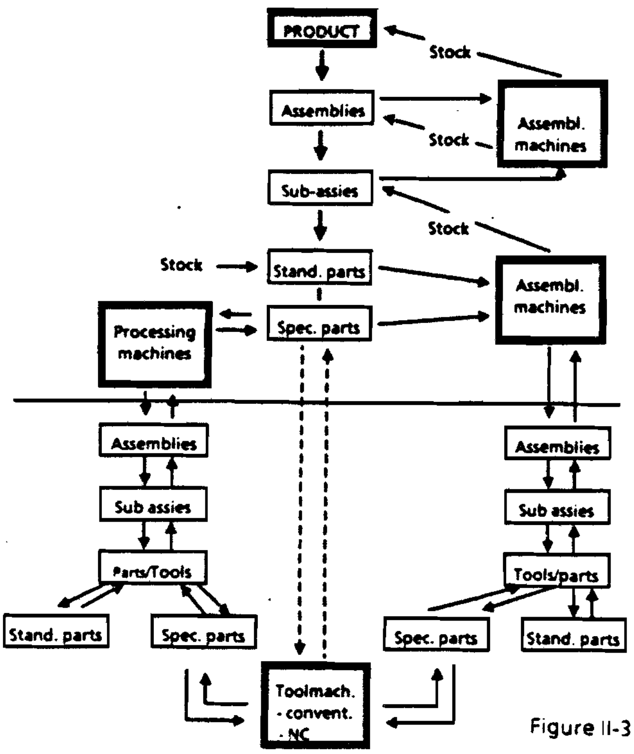


Figure II-3

Relations between product, production and productionmachines

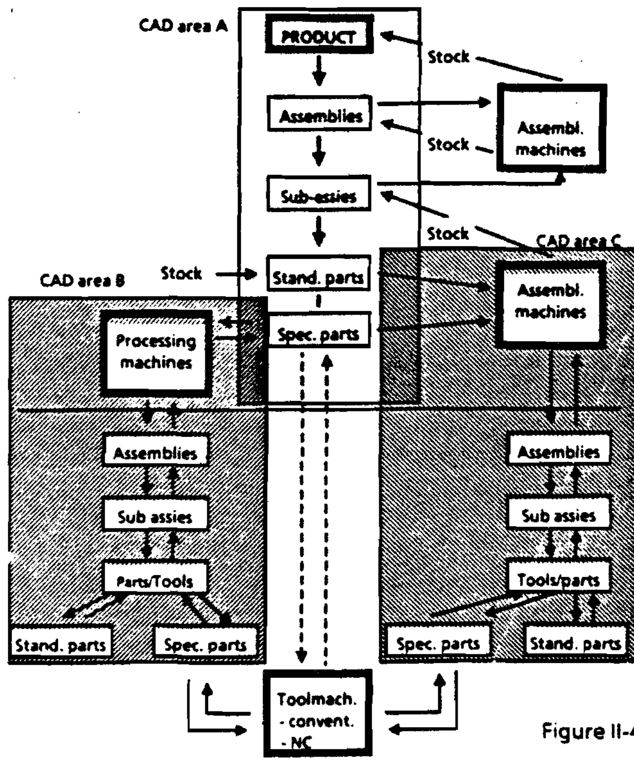


Figure II-4a

Relations between product, production and productionmachines

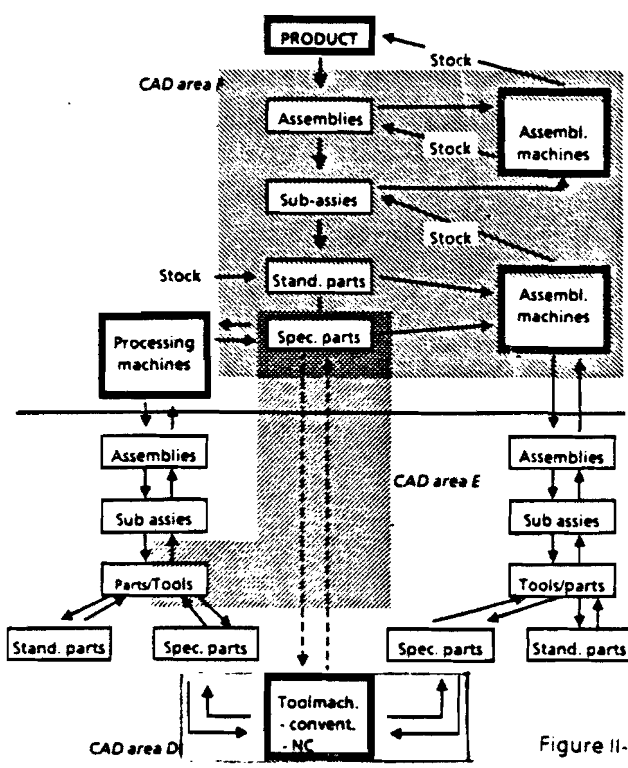


Figure II-4b

Relations between product, production and productionmachines

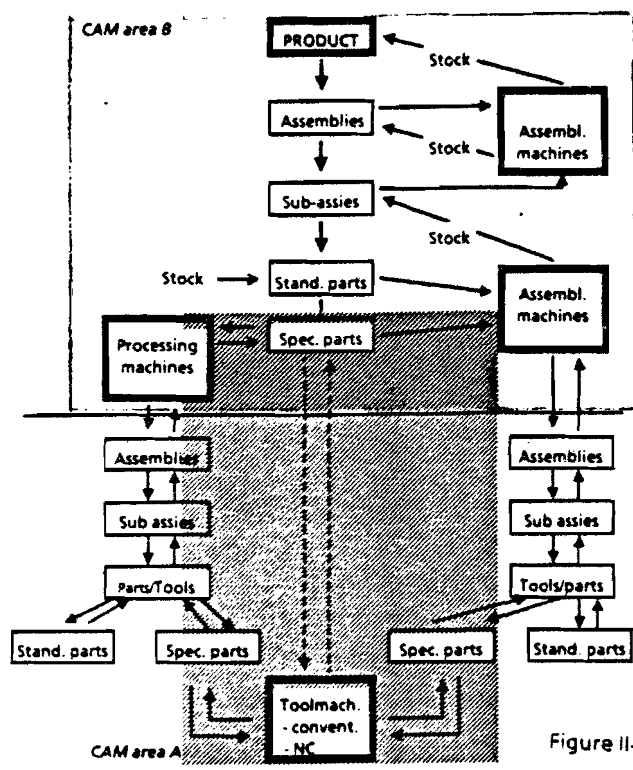


Figure II-5

CAD applications can be the same as in area A. They are more focussed on stress and deforming theories.

CAD-area C:

Also the assembly machines can be splitted up into functiongroups, sub-assemblies etc. CAD-area C covers the design and development of these machines.
CAD-applications can be the same as in CAD-area A but the are more focussed on speed and acceleration theories.

CAD-area D:

CAD area D covers the design and development of the tooling machines like NC-lathes and NC-milling machines .

CAD-area E:

CAD-area E covers the design of tools themselves used in the process machines.CAD-aplications can be the same as in CAD-area A. Other examples of CAD-applications are:
- simulation techniques
- process studies
- theories concerning the behaviour of the material

CAD-area F:

CAD-area F covers the design of plants, assembly lines and workstation layouts.
CAD-aplications can be the same as in CAD-area A.Other CAD-applications are:
- assembly simulation techniques
- optimising plant and office layout

2.4.2. CAPP-system

In this area the preparations of the work which has to be done by Manufacturing are made. For this reason it is closely related to requirements and specifications of the CAM-system.
E.g.: NC-file generating, automatic rebalancing, flexible cell simulation or the making of workinstructions.

2.4.3. CAM

In figure II-3 (relations between product, production and production machines) we can distinguish two different CAM-areas. Figure II-5 shows the same figure as figure II-3 but with the 2 CAM-areas are marked.

CAM-area A:

CAM-area A covers the manufacturing by NC-machines.Mainly professional products or products of which small numbers are required are made in this area.

CAM-area B:

CAM-area B covers the controlling, manufacturing processing, monitoring, etc. related to the production of a product. This production can involve the making of specific parts,

materials distribution from and to stocks, assemblying parts/assemblies, testing of assemblies/product etc.
CAM-area A and B do have a certain overlap; see figure II-6

<u>Different stages of manufacturing automation</u>

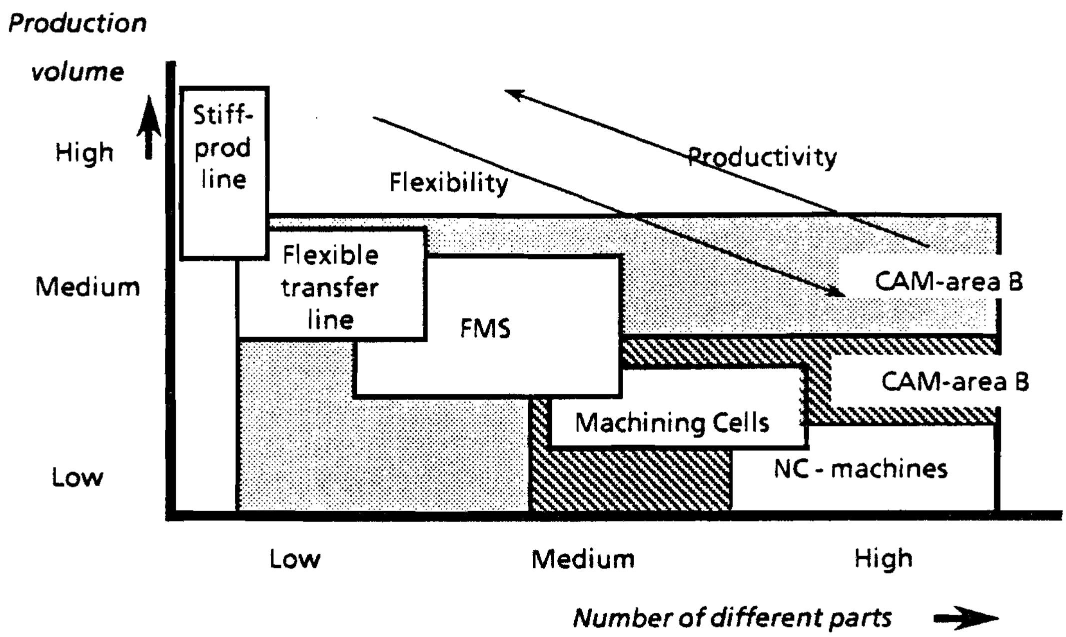


Figure II-6: Different stages of manufacturing automation

Standardisation in the automation of the Manufacturing activities can be found in M.A.P, lit[8,10].
The Manufacturing Automation Protocol (M.A.P.) is mainly designed to bring order in the automation of the Manufacturing activities. It is a kind of 'Esperanto' for the manufacturing environment The 'MAP-project' is initiated by GM, USA and is developed since 1980. It specifies the way in which different production systems should share their information in order to make communication between computer systems of different brands possible. It is based on the seven layers Open System Interconnection Model (O.S.I.) of the International Standards Organisation (I.S.O.). This O.S.I.- model divides the total productionsystem in functionlayers. This is done in such a way , that when implementing another process in one function, the other functions do not need to be changed. So MAP is strongly related to standardisation.
Unfortunately MAP is not yet completed, it is not yet an official standard and there are only a few MAP-products on the market. Nevertheless, the potential advantages of MAP justify an active policy in following the MAP-philosophy and the MAP-developments.

2.4.4. CAL-system

Logistics management stands for an integrated <u>control</u> of the internal and external materials flow.
In this report I only consider the <u>internal</u> materials flow.

Chapter 3: . MEASURING C.I.M. IN RANK XEROX

The Xerox CIM-strategy is vague. RXV could not give me a basic figure in which Xerox shows its strategy concerning CIM and which can support an integrated approach towards CIM in Venray. The only figure which could be considered for this reason and which I could find is shown in appendix 2.

In paragraph 2.3. I have defined the Complete CIM-System. In this chapter I will compare this Complete CIM-System with the CIM-system of Rank Xerox .

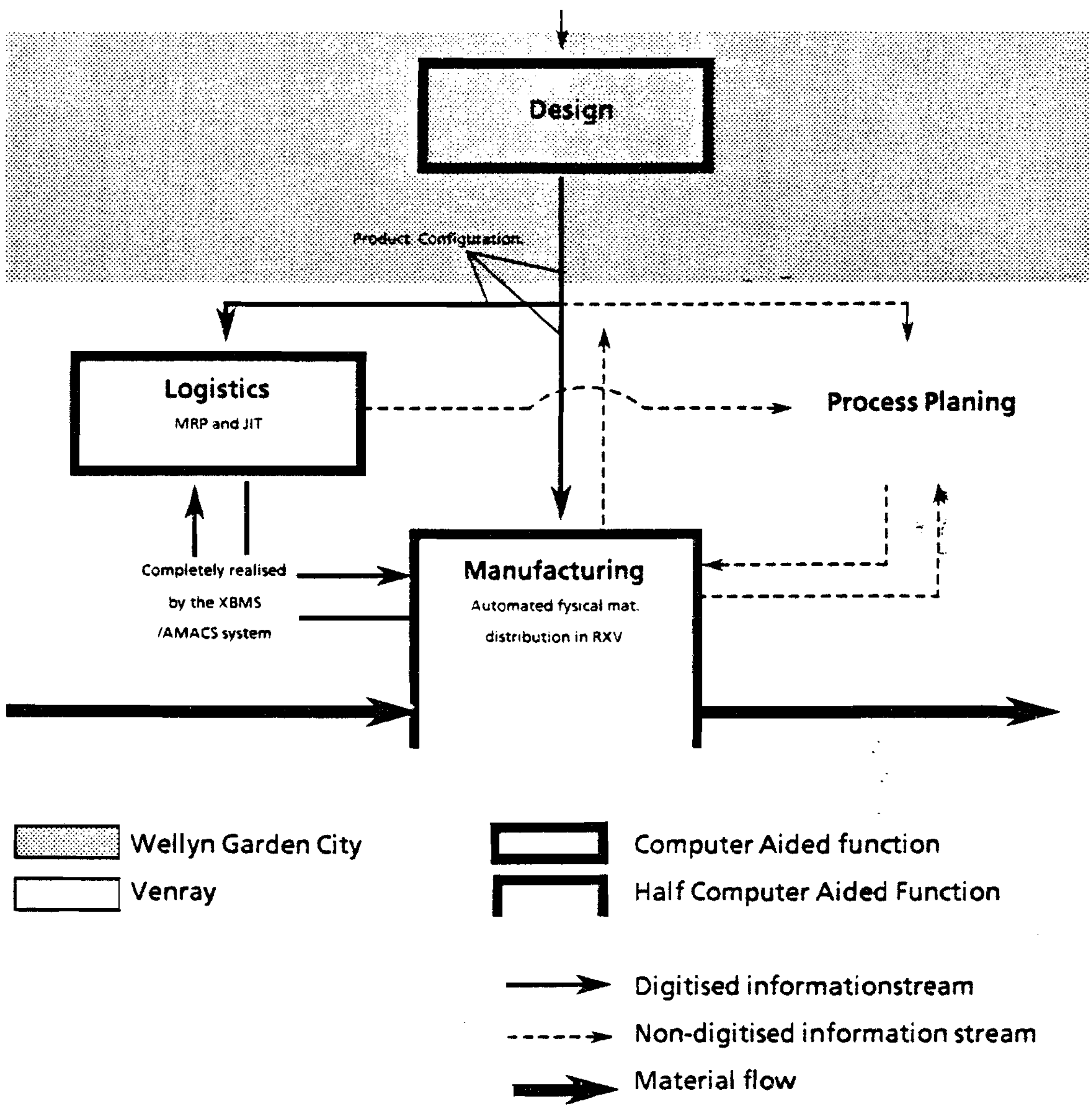


Figure II-7: CIM-system in Rank Xerox (Venray)

Figure II-7 shows the current situation in Rank Xerox (Venray) (in May 1987). The Design function in Rank Xerox is concentrated is Wellwynn Garden City, England. The other functions are carried out by different production plants in Europe. As to these other functions I have confined myself to RXV.

Figure 7 shows the computer aided functions and their linkages in Rank Xerox and Rank Xerox Venray. One can see that the following CIM-parts are present:

1. The information streams between Logistics and Manufacturing are already completely digitised in RXV.
2. Computer Aided Logistics will not need any improvements in RXV because planning and control are already fully automated.
3. CAD-systems are largerly used in Welwyn Garden City. This CAD-system does not give digitised geometrical data to the Manufacturing plant in Venray.
4. The productconfiguration is stored in a computer mainframe on which RXV has access.

One can also see in figure II-7 that the following CIM-parts are not present:

1. Process Planning is not computer aided.
2. The Manufacturing function is partly computer aided.
3. The transportation of productdrawings is not provided by a computersystem.
4. The information stream from Manufacturing to Design is not provided by a comouter system.

In order to realise the Complete CIM-System out of the current situation one has to realise step by step the various digital information links by the developing different computer systems.

Chapter 4: CIM-ACTIONS

4.1. Introduction

The following results can be expected when developing CIM:
- reduction of cost
- reduction of throughputtime
- improvement of the quality
- improvement of the product-mix-flexibility and the volume-flexibility

Cost reduction is a well known and largely required item. Cost reduction gets too much attention inside Xerox. Costreduction is indeed very important but if one still wants to be able to do costreductions in 1997 one must also take care of throughputtime reduction, quality improvement and flexibility improvement now !
It is therefore necessary not to remain blind and not to transform all of them into one main item "costreduction".
Interesting to know is that VOLVO-The Netherlands did not even mention costreduction as an objective for their CIM- project.

In this chapter I will consider three projects which will, ones completed, realise the Complete CIM-System in RX and in RXV. The projects themselves give good reasons to start with them, but when integrating these projects in the CIM-model we even get better results because 'the advantage of the whole is bigger then the advantage of the parts themselves'.
These three projects are:
1. Implementing an Intergraph CAD-system in RXV with standard applications.
2. Information systems to support 'Design For Production'
3. CAPP/CAM-systems in RXV and her vendors.

These projects are visualised in figure II-8.

I have distinguished these four projects for the following reasons:
1. Every project covers a clearly defined area in CIM-system in which RXV can give the necessary input.
2. Every project <u>can</u> be worked on independently .
3. Each project supports the other project to become a success. Once having fulfilled the three projects, Rank Xerox and Rank Xerox Venray have realisewd the Complete CIM-system.

<u>Note</u>:

The Complete CIM-System (figure II-2) consists of two information streams which will not be realised by the projects mentioned above namely:
1. The information stream from outside the company to the Design function
2. The information stream from Logistics to Process Planning
The first information stream is not interesting at all for RXV.
The second information stream can be realised very easily. The information which is now sent to Manufacturing must then also be sent to Process Planning.

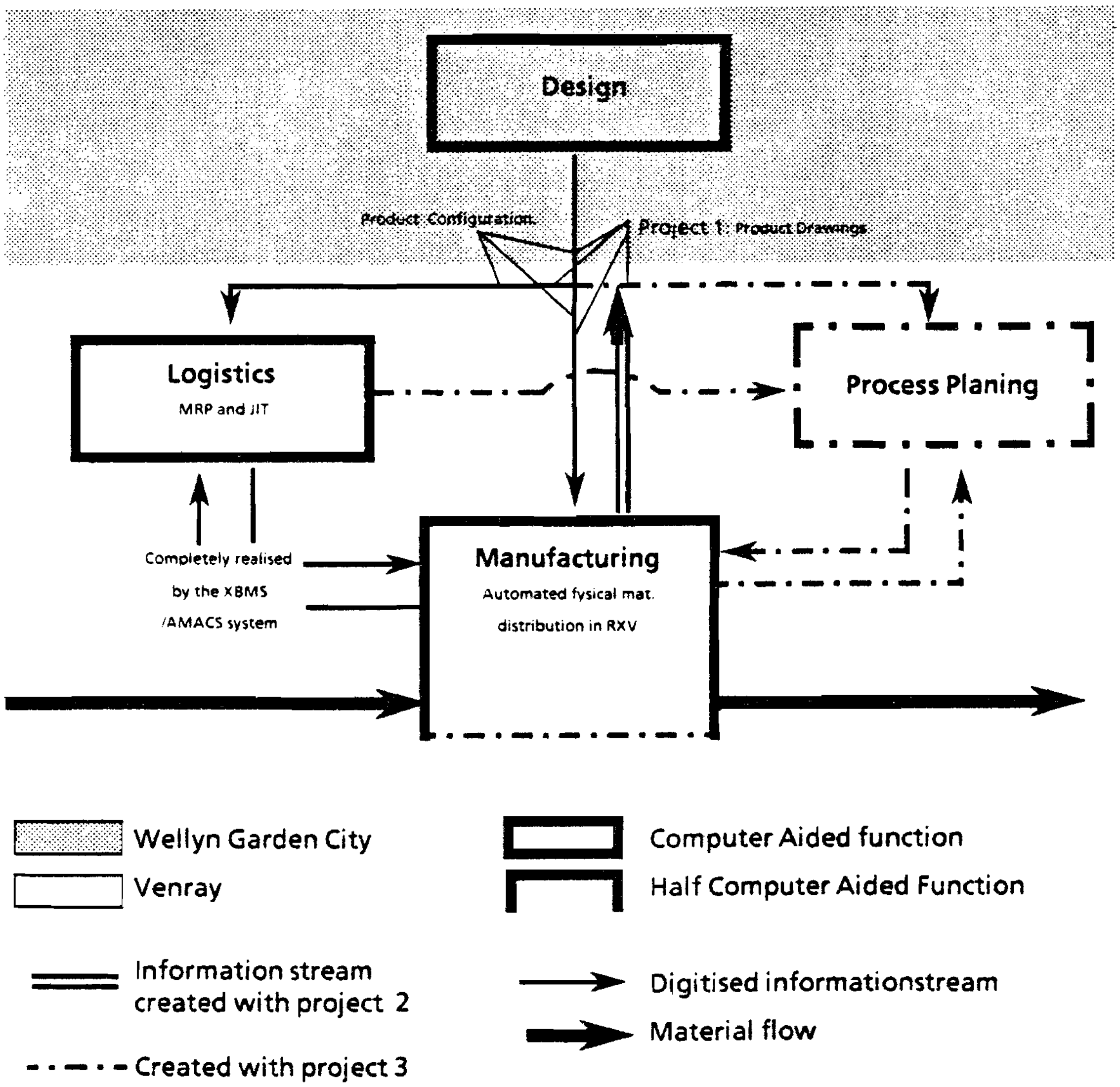


Figure II-7: Creating a Complete CIM-system in Rank Xerox (Venray)

4.2. CAD-system with the standard software applications

See figure II-8.
It is possible to overlook the aspects related with this project better then the other projects, especially better than aspects related with project four:'CAPP/CAM-systems in RXV and her vendors'.

Advantages of a CAD-system in RXV are:

1. Faster transportation of geometrical information.

This improves the communication between the Design - and the Development Phase and theManufacturing Phase.

Good communication has a big influence on cost reduction, quality improvement and throughputtime decrease. A quicker feedback of comments on drawings coming from the design center is possible as a result of the elimination of the "pipeline"effect. Better feedback possibilities can give a reduction of the change rate with positive impact on obsoletion and toolcosts.

More adequate control of common parts;
Suppose a new product is being designed in a design center which has a high commonality with an already existing product which is being produced in different production plants. When the design center uses CAD and the production plant, who has the design responsiblity of the already excisting design, does not have a CAD-system then two problems will occur. Firstly: all the common parts of the new machine have to be loaded into the CAD-system in the design center. This takes a lot of time.Secondly: it takes a lot of time to process a change request for a common part issued by the design center or the mother plant of the existing product; a transmission from geometric data and vice versa has to be made several times and again a lot of time is lost because of sending the draft information by mail.This situation indeed will occur in the near future when no action is taken by RXV because nearly all the copiers of the coming production program have their drawings stored in a CAD-system .

Taking into account these thoughts it might be said that in 5 years' time there will be no development functions in plants which do not posess a CAD-system. There will be too much time lost by sending the draft information by mail and by transmitting the drafts from geometric data to hardcopy and vice versa.

Another advantage of a CAD-system is that the last updated geometric data about a part or assy will always be available for every user. This also goes for drawings in RXV.

Better communication between different disciplines in a company can also be accomplished by other solutions than implementing a CAD-system. For example by improving the communication between the commodity teams or by forming design teams with some manufacturing engineers included. This is also what happens now in Xerox by means of the MRT-teams.
Yet another solution to avoid unnecessary transformation of data is not to give the design responsibility or a 'pilot function' to plants which do not posess a CAD- system.

<u>2. Faster changing of drawings.</u>

A CAD-system makes a faster changing possible of product drawings, tool drawings, exploded views and product configurations.

Manipulating already existing drawings is one of the big advantages of a CAD-system.

<u>3. Quicker design of higher quality.</u>

This advantage goes for the design work of: products, tooling, harnesses shop floor layout , packaging or electrical engineering.
One must not expect too much of this advantage. Experiences with CAD-system in WGC show that the quality of a detailed drawing made on a CAD-system is low. That is a pity because the advantage of a CAD-system can not be found in rough design work.

A result of a design of higher quality is a lower change rate. To my opinion this advantage does not count in case of Rank Xerox Venray because nearly no new design is made in Venray.

4. More flexibility in the PDP as a result of point 1 and 3

5. Improved opportunities to make project 2,3 and 4 to a success.

Costs related with a CAD-system:

(See appendix 4 for the exact cost calculations)

Total anual cost reduction could amount to:	$ 184,000	when implementing 3 work-stations.
Implementation costs amount to:	$ 160,000	when implementing 1 work-station
Maintenance costs amount to:	$ 8,000	

When I compare the costs and the costreductions related with installing a CAD-system in RXV I conclude that a CAD-system in Venray can not be justified on account of purely costcalculcations.

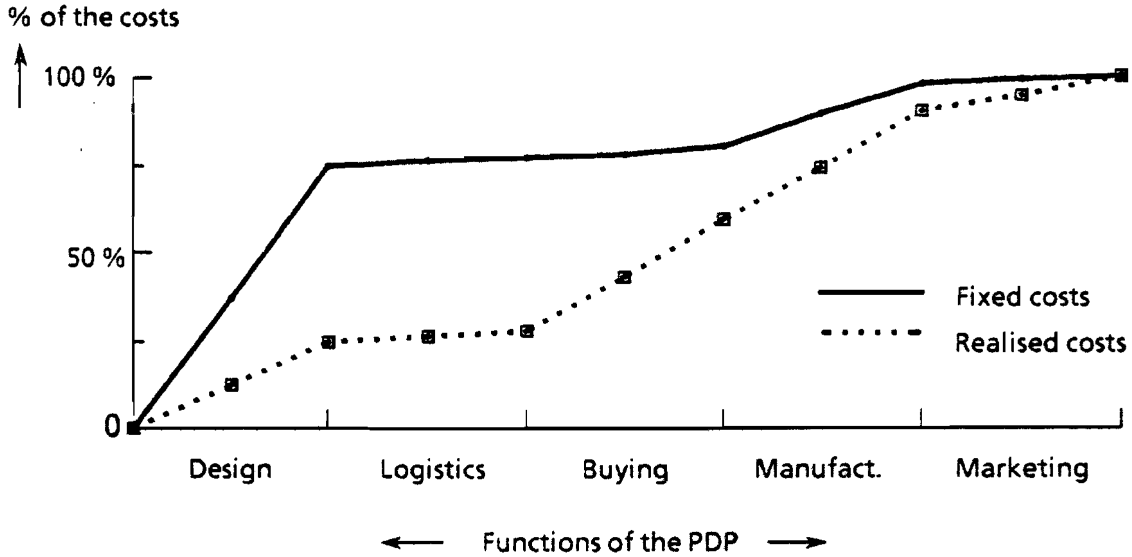
4.3. Informationsystems to support 'Design For Production'

Allthough the design phase is not the most costly phase in the live of a copier , it is a very important phase for reducing the total costs of a product. In this phase most of the product costs are fixed ! The design phase contains therefore many possibilities for influencing the total costs. Figure II-9 illustrates this devision of costs made in an average production system. This figure is taken from lit.[11].
The functional demands made on the product have reference to product strength, duration of life, product appearance, maintanance, manufacturing costs, product quality, product safety etc; the demands are often incompatible. Finding a compromise between these demands requires a high inventiveness of the designer. When also the production will issue its own demands for the product then it will be even more difficult for a designer to find an acceptable solution. Yet this is what 'Design For Production' does. This may be seen as a dis-advantage of 'Design For Production'; every extension of the requirements on a product can be called a threat for the creativity of the product engineer. I do not agree. An accomplished designer is he who can integrate all the requirements in his design. Optimising to one aspect will give no difficulties, finding the right solution will.
For the designer 'Design for production' means a heavier task and/or a challenge. See also lit[11].

Reasons to promote 'Design for Production' (DFP) are the expected decrease in costs during the Manufacturing Phase. This is the result of an expected lower change rates in parts, assemblies and tools and a cheaper production of higher quality. Design For Production also encourages the usage of standard parts and functions. Applying standard parts and functions in a product has three main important results for production:

- Fewer amounts of different kinds of parts;
  This results in a more simple materials flow, reduced storage areas and reduced obsolence and spoilage hazards. This also results in a higher flexibility in the production.
- Larger lot sizes;

Figure II-9: Fixerd costs and realised costs in the PDP



This results in reduced costs per unit, more constant quality of raw materials and reduced and simplified inspections of shipments

- More experience and knowledge about a certain function or assembly;
  This results in reduced costs for the Industrial Engineering Department, more efficient production and workmethods, a higher product quality and a shorter throughput time.

Especially when CIM-systems are realised there will be more requirements for the product design in order to receive the benifits of the automations systems. So developing CIM-systems resluts in more requirements for the product designer to know.

The computer can support Design For Production efficiently. (lit.[15]) Advanced information systems with information about the production can be made. These systems can help the designer in finding interesting information about the production which is related to the product design he is working at. One can work with a central database to which every designer has access. In that case every user of the information system will work with the same, latest updated version.

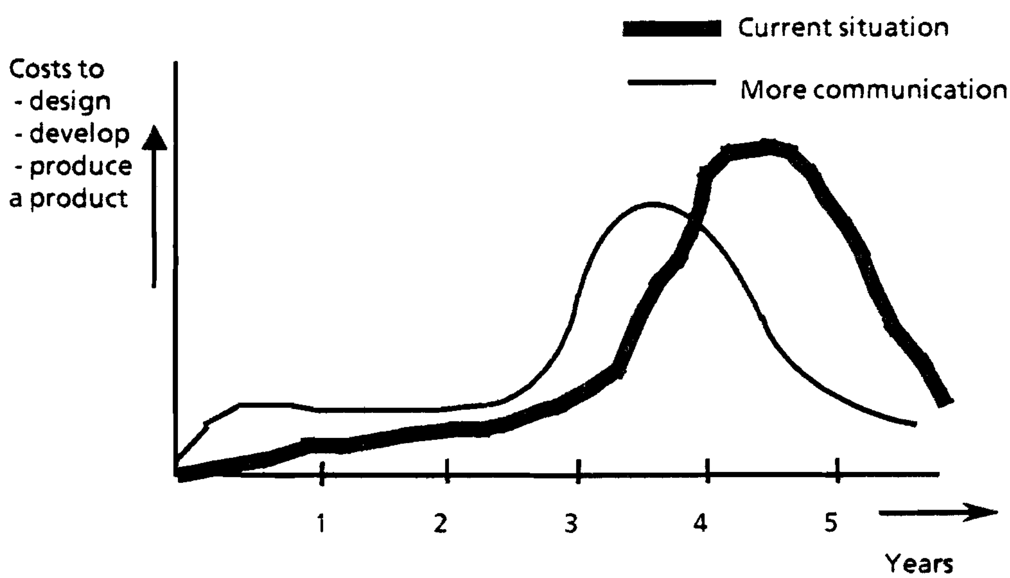
The Xerox data sharing network there is no computer system which provides a 'hard' link back from Manufacturing to the Design.
One has to distinguish two different kinds information systems according to the two different kinds of information which is useful for the designer (and which is useful for the production after being applied in a design):
1. information system with information about standards
2. information system with manufacturing requirements.

So the advantages of Informationsystems which support Design For Production are:

1. Decrease in costs in the Design function and the Manufacturing function.

Figure II-10 shows the result which Design For Production wishes to accomplish.

Figure II-10 Realised costs versus costs



Three managers estimated the yearly costreductions as a result of an operational information system with information about standards on: $ 6,500,000.- (!!) (see appendix 4)
It is not possible to calculate the costreductions of an information system with information about manufacturingrequirements. I have tried to do it, see appendix 4, by calculating the XCN's which would not have been issued when such an information system would have been available for the designers. This resulted in an expected anual costreduction of $ 250,000.- .
The costreductions and the costs of every information system which support DFP will have to be considered seperately for every system. This is what I will do in the next project for an information system about the finishingprocesses. (see part III of this report).

2. Decrease of the total throughputtime of a copier in the PDP.
   This can be achieved by a better availibility of the production related information and by a greater attention for production related aspects in a design.

3. Increase of the flexibility of the production.

4. Higher product quality.

4.4. CAPP/CAM-systems at Rank Xerox Venray and its vendors

CAPP/CAM -systems cover a very big area. Therefore it is not possible nor appropriate to define the exact (dis)advantages one has to deal with when realising these systems. Every CAPP or CAM-project needs a survey on its own. However, it is very important that the 'soil in the company is fruitful' to make these projects to a success.

Possibilities:

1. Reduced leadtime
2. Flexibility improvement
3. Reduced parts costs
4. Reduced tool tryout
5. Reduced scrap costs
6. Reduced special tooling

According to the definitions mentioned in paragraph 3.1.4. one can apply CAM in the following two areas:

1. Production of professional products (CAM-area A).

Mainly professional parts or parts of which small numbers are required are manufactured in this area. An example are the paintrobots in RXV. In order to obtain more of the possible advantages mentioned above RXV can take two actions: First, take back part of the production of the parts from the suppliers and have RXV produce the parts . In this case the tools needed to make the parts can be made by NC-machines. Second, one can start the production of prototypes.

But when doing this one has to take in account that when taking back the production of certain parts one also has to take back the related technology. And keep in mind that CAM will not improve the control of this technology.

2. Production of assemblies (CAM- area B):.

The production plant in RXV already has an Automated Handling System linked to the MRP-system. It includes automated storage and automated supply to the assembly line by AGV's.
It now seems a logical step to complete the CAM-story in RXV. This means automating the assembly of the (sub) assemblies with the aid of robots and FMS's.

Two remarks:
- Completing the CAM-story in RXV means automating the manual assembly by robots and FMS's. Although it is very fashionable these days to talk about these new technologies one should again distinguish two important things namely technical possibilties and economical requirements.
- a CAM-system will not improve the control of the technologies used by the CAM-system

Chapter 5: CONCLUSION

I end this essay with the following proposals:

1. Use the CIM-model which is shown in figure II-11 as a basis for the CIM-strategy of Rank Xerox Venray.

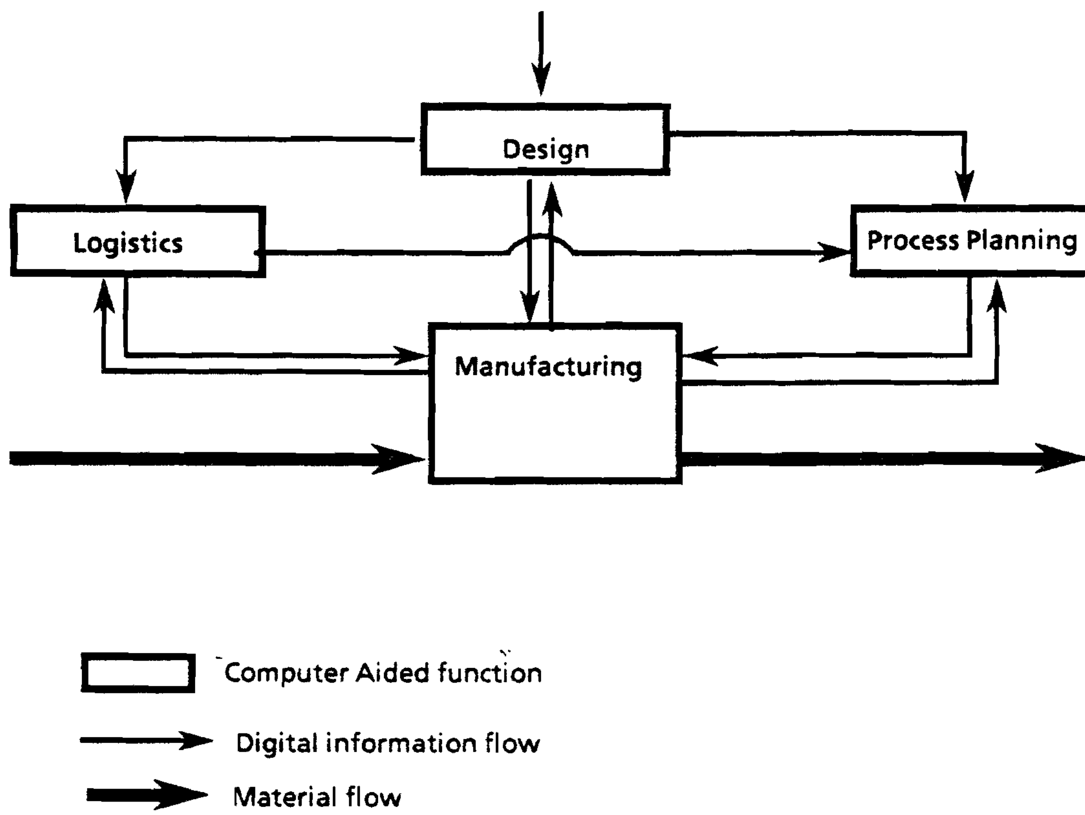


Figure II-11: CIM-model

2. Use the term "Complete CIM-System" for a CIM-system in which:
   - the work which is done in the different functions of the Product Delivery Process is aided by computer systems;
   - the information streams between these functions are provided by linkages between computer systems.

3. In order to realise the Complete CIM-System out of the CIM-system which excists in RXV nowadays, RXV will have to realise the following projects:

   1. Implementing an Intergraph CAD-system in RXV with standard applications.
   2. Informationsystems to support 'Design For Production'
   3. CAPP/CAM systems in RXV and her vendors.

   The results of these projects are shortly mentioned in table II-1.

	Return on investments	Flexibility-improvement	Throughput-time decrease	Quality improvement
Project 1: CAD-system in RXV	4 years	Yes. As a result of the through-puttime decrease.	Yes. Due faster information-transport, faster drawing processing	?
Project 2: Systems to support DFP	consider systems on their own	Yes. Design is better attuned to Manufacturing	Yes. Better availibility of information and a better tuning of the design to the production.	Yes. Design is better attuned to Manufacturing
Project 3: Realising CAPP/CAM	consider systems on their own	Yes	Yes	?

I end this essay with two recommandations:

1. Use the proposed CIM-model in order to link and to structure the different actions which will be taken in accordance with CIM .
2. Perform feasibility studies on the different projects which are mentioned in this essay.

Note:

Since November 1987 RXV posses an Intergraph CAD-workstation.

PART III

THE INFORMATIONSYSTEM INFOFINISH

CONTENTS OF PART III

Chapter I: INTRODUCTION

The product designer has many decisions to make when designing a product . He makes these decisions in such a way that he will fulfill the wishes of the customer, the production, safety and the field in the best way. Every decision has its influence, (big or small) on the characteristics of the production and the processes used. Therefore it is important for the designer to have at his disposal the knowledge, the experience and the requirements of the production and the processes used, as well as the safety and field requirements.
Rank Xerox Venray believes that it is possible and useful to offer the product designers information about the production by means of an information system which is based on a computer.
Such an information system should enable the designers to adjust the product designs to the requirements of the production. This enables the production to produce the product with the required quality and the lowest costs.
For more backgrounds of such an information system see Part II, paragraph 4.3. 'Informationsystems to support "Design for production"'.

Task

Mr. Van Ophuizen gave me, on behalf of RXV, the task to make a start with the project which ends up in an:
"Information system with information about the finishing processes for usage by the product designer. This sytem must help the designer to attune his product to the finishing - processes. It is based on computers".
So the wish to supply the designer information about a broad range of production processes is reduced to supplying the designers information about certain production processes: the finshingprocesses. Why the finishing processes are chosen can be read in appendix 5.

Objectives

The following objectives will have to be reached with this information system:(see for a more extended description of these objectives Part II, par. 4.3.)

1. A reduction in costs during the production and maintanance phase.This is the result of an expected lower change rate in parts and tools and cheaper finishing processing costs.
2. Decrease in total throughputtime. The product designers will be efficiently informed about the requirements of these processes for the product.
3. A quality improvement of the product because the designer is supported to tune his designs better to the requirements of the finishing processes.
4. Efficient feed-back possibilities.
5. A better insight in the problems which will occur when creating these kinds of information systems.

Project strategy and methods used:

I have worked on this project according to the project strategy Sytem Development Methodology (SDM) (lit.[4]). See Part I, chapter 3 for a description of this strategy and for the planning which was made for the development of the information system. The techniques proposed by Yourdon are used (see Part I, paragraph 3.4. or lit 7) for the documentation of the information system.

Contents of this report

The first three phases of the development of the information system are completed: the Definition Study, the Functional Design Phase and the Technical Design Phase. This report contains all information needed for the continuation of the project. So it also contains information which is already published.(lit.[5] and [6]).
Chapter 2 considers the finishingprocess; it compares the information needs of the designer and the current situastion of the supply of information to the designer. This comparing of two situations leads to the requirements for the ultimate, computer based, information system which these are mentioned in chapter 3.
In chapter 4 the possibilities and the working of the designed information system are described.
Chapter 5 discusses further development of the system INFOFINISH. such as the most appropriate hard and software to use, and other requirements for a successful system.
Chapter 6 gives a discussion of the (dis)advantages of the system.
Chapter 6 I gives conclusions and recommandations.

Consulted information sources

The information sources I consulted while working on this project were:
- Mr Brandsma who is the finishing expert of RXV; I worked closely together with him while working on this project.
- Manuals, Reports and Publications with information about the finishing processes
- Mr Mainard who is a member of the Xerox Finishing Team

It was not possible to receive information from the designers themselves.

Chapter 2: THE FINISHINGPROCESSES

2.1. Definition of a finishing process

A finishing process is a manufacturing process which gives the following characteristic property to a product: The surface of a product which is processed contains better mechanical, estethical or corrosion resistance properties then before being processed. This is realised by treating the surface itself or by adding a thin coating on it.

2.2. Information about the finishing process needed by the designer

The following subjects on a product design have their influence on the quality and the costs of the finishing processes:
- shape of the product;
- measures of the product;
- raw material specification;
- finishing specification-code; this code specifies the required values for the characteristics of the ultimate surface of the product;
- indication of the part of the product-surface on which the given finishing specification must be realised.

In order to help the product designer to attune these subjects of his design to the finishing processes he needs te following information:
1. Support for the designer's selection of the most appropriate finishing specification which must be applied to the considered product.
2. Information about finishing specifications.
3. Support for the designer's selection of the most appropriate finishing process which must be applied to the considered product. This is absolutely required because supplying the information about a certain finishing process is only useful when this is an appropriate finishing process.
4. Information about the requirements of the finishing processes for the attributes of the product to be processed.
5. Information about the costs of the finishing processes.

2.3. Current situation

2.3.1. Where and how to find the needed information

In paragraph 2.2. the information, wich the designer needs in order to be able to attune his product design to the finishing processes, is described. This paragraph describes where the designer can find this information in the current situation.

ad 1: Support for the designer's selection of the most appropriate finishing specification which mustbe applied to the considered product.

The Multination Engineering Manual (MN) number 3 (lit.[12]) contains rules which can help the designer to choose the best finishing specification-code for his purpose. In fact this help is very marginal.

ad 2: Information about the finishing specifications

The designer must specify the required values for the characteristics of the ultimate product by means of a finishing specification-code on the drawing. The designer can find the specifications of these finishing specification-codes in the Multinational Engineering Manual number 6 (lit.[13]). Every finishing specification describes other performance criteria for a surface of a product. MN 6 contains approximately 300 finishing specifications.
The descriptions of the finishing specifications in MN6 are not accurate nor complete. E.g.: many attributes of a finishing specification are mentioned only in those specifications which have an exceptional value for that attribute. For example: in the spec "Chromium Electroplated" the very high abrasionresistance is mentioned but its corrosion resistance, which is also quite good is not mentioned. MN 6 does not contain an index by which you can easily find the finishing specification you need.

ad 3: Support for the designer's selection of the most appropriate finishing process which must be applied to the considered product.

This information is not available .

ad 4: Information about the requirements of the finishing processes for the product to be processed.

This information can only be found in little publications which are made individualy by the different finishing experts in Xerox. For the rest, if a designer wishes to have more information of this kind then he will have to contact a finishing expert.

ad 5; Information about the costs of the different finishing processes

This kind of information is not specified at all.

Conclusion

Only, let's say, 25 % of the information which is needed to help the product designer to attune his design to the finishing processes is available. This information is divided over different publications.

2.4.2. The tuning of the product designs to the finishing processes

Mr. Brandsma (finishing expert inside RXV) and with Mr. Mainer (member of the Xerox Finishing Team) said the following about the tuning of the product designs to the finishing processes:

1. The given finishing specifications on a drawing are often not the most appropriate ones.
2. The designer makes to little allowance too the requirements of he finishing processes.
3. When a product designer would have all the knowledge of a finishing experts at his disposal then approximately an annual amount of M$ 1 to 2 would be saved on finishing costs made by Xerox.

A not appropriate finishing specification can be changed later on but a wrong product design can hardly be changed.

The statements above are not clear; there are no hard figures. Therefore I tried to gather some figures myself about the tuning of the product design to the finishing processes; I also did not succeed in getting hard figures but these surveys gave me an indication:.

1. I did a survey* to the amount of Xerox Change Notices (XCN's) which affected the finishing specification and which were issued in the period 1- 10-1985 until 1-10-1987 for the 1045 family copiers. It appeared that 10 XCN's were issued in order to change or to add a finishing specification on a product drawing. The cost of an average XCN amounts to $ 5000.- so the mentioned 10 XCN's cost $ 50,000.-. See appendix 3 for information about an XCN.

2. I did a survey* to the amount of CRLV's which affected the finishing specification and which were issued in the period 1- 10-1983 until 1-10-1987 for the 1045 family copiers. It appeared that 66 CRLV's were issued in order to change or to add a finishing specification on a drawing. The cost of a CRLV can not be estimated.See appendix 3 for information about a CRLV.

* See appendix 6 for a description of the method which is applied for this survey.

There are no figures about costs made in production as a result of bad product designs which are not changed by an XCN. There are also no figures about the quality of the designs which are not changed.

The conclusion which may be drawn out of the surveys above is that the tuning of the product designs on the finishing processes is normal; not good and not bad.

Chapter 3: REQUIREMENTS FOR THE INFORMATIONSYSTEM

Chapter 2 describes the information about the finishing processes which the designer should have at his disposal. It also describes the current information system and its shortages. In this chapter the requirements for the information system which must be developed by this project are specified.

The information system must be able to give sufficient*:

1. Support for the designer's selection of the most appropriate finishing specification which must be applied to the considered product.
2. Information about the finishing specifications.
3. Support for the designer's selection of the most appropriate finishing process which must be applied to the considered product. This is absolutely required because supplying the information about a certain finishing processes is only useful when the appropriate finishing process is concerned.
4. Information about the requirements of the finishing processes for the attributes of the product to be processed.
5. Information about the costs of the finishingprocesses.

Further more:

6. Updating the information in the system should be easy for laymen where a computer is concerned. This enables efficient feedback of new information and/or experiences about the finishing processes to the product designers.
7. The system must be accessible for all Xerox product designers.
8. The system must be userfriendly including the updating program.
9. The system must be protected in such a way that only persons, who are allowed to update the system, have access to the updating program of the system.
10. The information system must be fast.
11. The information must be given in a way which is easy to understand.
12. The techniques used to build the system must be appriopriate for at least the next 5 years.

* The user of the information system decides whether the system meets these requirements.

Chapter 4: THE INFORMATIONSYSTEM INFOFINISH

4.1. General description of INFOFINISH

This paragraph will inform you about about the possibilities of the information system which is designed. The rest of this chapter discusses its working and its structure more in detail.

The information system is called: 'INFOFINISH'.

INFOFINISH can be divided into 4 sub-programs: KINFO, SPECINFO, PROCINFO and UPDATE;

KINFO:
This sub-program is the most extended one and the most important one. KINFO helps the user to select the most appropriate finishing specification and -process for the considered product design. Meanwhile KINFO gives information about the interesting finishing specifications and -processes. This can be a general kind of information but it can also contain the wishes or absolute requirements of the finishing processes for the product to be processed. KINFO also gives general costindications of the chosen finishing specifications. On user's request it can also calculate the exact costs of realising a finishing specification by means of a certain finishing process.

To be able to do so KINFO asks specific questions about:

- the user's wishes for the ultimate characteristics of the product; Every characteristic is explained broadly if the user tells KINFO to do so. KINFO takes into account that the user might not be sure about wishes for certain characteristics. Therefore KINFO offers the user the possibilities to give more than one wish for these characteristics. KINFO then determines the most appropriate finishing specification and -process for every possible combination of wishes. KINFO also takes into account that the user finds some wishes more important than other wishes; therefore the user can give the importancy of every wish on a scale from 1 to 5.

- the product design which is being considered by the user.

PROCINFO
This sub-program gives information about a certain finishing proces or a certain collection of finishing processes. This information can be general information about the product but it can also contain absolute requirements or wishes for these finishing processes. The user is also being told what happens if he does not meet to these wishes. On user's request PROCINFO can also calculate the exact costs of realising a finishing specification by means of a certain finishing process.

SPECINFO
This sub-program gives information about finishing specifications. The user can ask for information about certain finishing specifications which meet to the constraints made by the user himself. The information about the finishing specification contains all the values which this finishing specification has for all the possible characteristics of a finishing specification, see paragraph 4.3.1., plus some remarks. SPECINFO also gives an indication of the processing costs for realising the selected finishing specification.

UPDATE
This subprogram gives the possibility to update the information which is present in the database. So it is possible to replenish the information in the system if the user finds that the information given by INFOFINISH is not sufficient.

4.2. The essence of INFOFINISH

Attuning the product design to a finishing process which is not the most appropriate one is useless. This does not mean that the user of the information system must receive the support of the selection for the most appropriate finishing process first and strictly divided from the other information about the finishing processes; when the user received information about the finishing process he might change the product design. After this change the most appropriate finishing process might be another one than the one before this change.
So the information system must simultaneously give:
- assistance to the selection of the appropriate finishing process;
- information about the finishing processes

The following describes the way in which INFOFINISH looks at a product and at a finishing process;

INFOFINISH assumes that every product can be described by giving the 16 characteristic attributes of a product. See paragraph 4.3. for a description of these attributes.
The designer knows what attributes the product has before it is processed. I will name these attributes the commencing attributes of the product.
He also knows what attributes the product must have after it is processed. I will name these attributes the ultimate attributes of the product.

INFOFINISH assumes that every finishing process can be described by giving the following attributes:
1. The possible commencing attributes of the products to be processed.
2. The possible ultimate attributes of a product after being processed; these can be realised depending on the presence of certain commencing attributes of the product.
3. The processing costs related with the commencing product attributes and the ultimate product attributes.

See figure III-1.

INFOFINISH first asks the user what values the user wishes for the ultimate attributes of the product. Then INFOFINISH searches for the (those) finishing specification(s) of which the specifications are equal or nearly equal to the wishes of the user. After having found the interesting finishing specifications INFOFINISH considers all those finishing processes which can REALISE the ultimate attributes mentioned in the finishing specifications. But, every finishing process has its own requirements for the commencing charactersitics of the product; depending on the presence (or the absence) of certain commencing attributes of the product it can realise the required ultimate characteristics. Therefore KINFO asks the user to give information about the commencing attributes of the product. These questions have reference to the selected processes.

In the end INFOFINISH knows which finishing specification specifies the user's requirements the best and which is the most appropriate finishing process to realise these requirements. INFOFINISH shows these two to the user. Besides that it also shows the user interesting alternatives.
The exaxt working of INFOFINSIH is described in appendix 7.

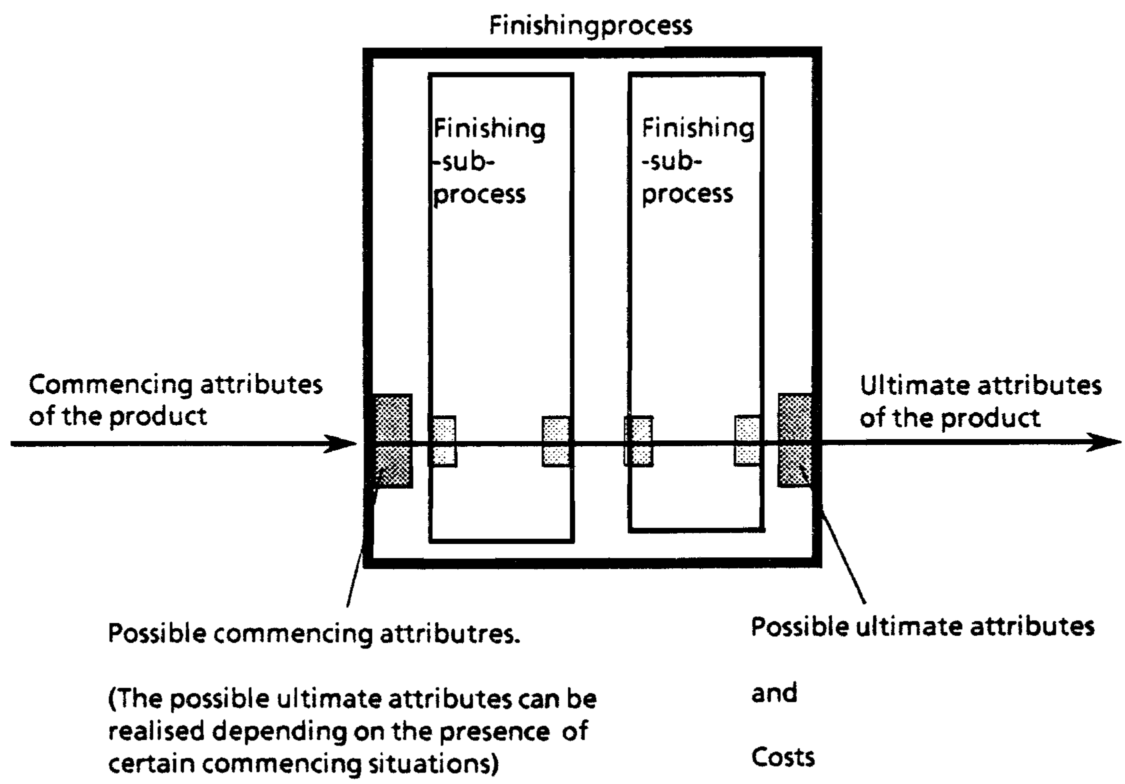


Figure III-1: Finishingprocess

<u>Some remarks</u>

1. It would be quite logical to consider the processing costs also as an ultimate attribute of the product. Nevertheless I (and KINFO) consider the costs of processing as a seperate attribute of a finishing process because the processing costs are in fact a very special ultimate attribute of the product; The difference with the other ultimate attributes is firstly: one always wants the costs-attribute to be as low as posible, and secondly, one always wants the costs-attributes to be as low as possible <u>after</u> all the other required attributes are realised.

INFOFINISH assumes that only one finishing process is needed to give the required ultimate attributes to a product. In reality one can see that nearly always more sub-finishing processes are needed. For example first a pre-treatment and after that painting with a red color. INFOFINISH considers these two processes as being <u>one</u> finishing process; it has one name and it has the attributes mentioned above. Theoretically this is a reduction in the quality of INFOFINISH. Practice shows that the requirements for INFOFINISH still can be reached and that it simplifies the working and the using of INFOFINISH.

4.3. Datastructure; the basis of INFOFINISH

The datastructure is the basis of the whole information system. Therefore a rather long paragraph is spent on an extended description of the data and the data structure used by INFOFINISH.
The system INFOFINISH works with two datafiles which describe the two relevant objects in the system: the finishing specification and the finishing process.
The datafile SPEC contains the descriptions of all the interesting finishing specification-codes and is described in paragraph 4.3.1.. The datafile PROC contains the descriptions of all the finishing processes and is described in paragraph 4.3.2.

4.3.1. The datafile SPEC

The datafile SPEC contains a description of all the interesting finishing specifications (approximately 100 when the system is ready for usage). Every finishing specification is described by giving its values for the attributes of a finishing specification. In this paragraph every attribute is defined. The attributes of a finishing specification are the same as the ultimate attributes of a product considered by INFOFINISH.
For the most part, the definitions of this data can be read without any explanation once the mathematical operators, or notations are understood. These are defined as follows:

x = a + b	x consists of data elements a and b
x = [a b]	x consists of either a or b
x = (a)	x consists of an optional data element a
x = {a}	x consists of zero or more occurences of a
x = y{a}	x consists of y or more occurences of a
x = {a}z	x consists of z or fewer occurences of a
x = y{a}z	x consists of between y and z occurences of a

For example " COWS = 2{COW}" means that the objects COWS consists of one or more occurences of the object COW.

The attributes of a finishing specification are:

1. Number of the finishing specification = 5{digit}5
2. Finishingspecification code = 4{digit}4
3. Thickness increase = [0 I 1 I 2 I 3 I 4 I 5]
4. Hardness = [0 I 1 I 2 I 3 I 4 I 5]
5. Abrasionresistance = [0 I 1 I 2 I 3 I 4 I 5]
6. Corrosion resistance = [0 I 1 I 2 I 3 I 4 I 5]
7. Raw material = [XX I ST I AL I SS I CO I PW I FP I PL I ZD I FA I NF]
8. Color = 0 {character} 25
9. Color and appearance number = 4 {digit} 4
10. Reflectivity = [A I X I R I N]
11. Dielectric strength = [Y I N]
12. Insulation resistance = [Y I N]
13. Friction = [H I L I N]
14. Greasing attribute = [Y I N]
15. High temperature resistance = [Y I N]
16. Flexibility = [Y I N]
17. Elongation = [Y I N]
18. Cost-indication = 4{digit} 4
19. Finishingprocess code = 10{character}10
20. Remarks = 0{character}25

The following attributes do not exist in the datafile SPEC but all the finishing specifications meet these requirements. They may be shown to the user as extra information:
- Adhesion
- Cleanability and tonercompatibility
- Heat resistance
- Exposure stability
- Chemical resistance

A ppendix 8 gives a broadend description of all the attributes of a finishing specification.

4.3.2. The data file PROC

The data file PROC contains information for the finishing processes. More exactly: PROC contains information about collections of finishing processes. Every collection of finishing specifications is indicated by a finishing process-code. An example of a collection of finishing processes is the "zinc electroplating" or also "zinc electroplating of steel".
In the rest of this paragraph I will only consider collections of finishing specifications. This is a very long word, Therefore I will also use the word finishing process in state of collection of finishing processes when there is no chance for confusions.

Every occurence of the object "finishing process-collection" is specified by:
1. One finishing process code. This is the key of the file PROC.
2. General information about the finishing process.
3. Absolute requirements of the finishing process for the commencing attributes of the product to be processed. If the user does not meet these requirements than the finishing process can not be applied for realising the users' wishes for the product surface.
4. One or more wishes of the finishing processes for the commencing attributes of the product. If the user can not fulfil these wishes than this will mean that the finishing process can not fully realise the required characteristics.
   Therefore INFOFINISH takes a reduction-ratio into account which is also part of this attribute.
5. Reference to the place where the costcalculationprogram for the finishing process-collection can be found. This can be used if the user wants to calculate the exact costs of realising his wishes with one of the finishing processes out of the considered collection.

The structure of the finishing process code

The structure of the finishing process-code subdivides all the existing finishing processes into collections of processes. Together with Mr. Brandsma I chose to subdivide the finishing processes in the same way as it is being done by Van Der Klis. lit.[18]. This choice is not based on a thorough investigation on existing subdivisions of the finishing processes. I wonder whether that would have resulted in a better choice for the subdivision because the requirements for this subdivision to be used are only very vague to make.
Mr. Brandsma and I compared two ways of distinguishing the finishing processes: the "surface finishing system" of Rudzki (lit.[17]) and the subdivision of Van Der Klis. These two appeared to be a lot alike. After some discussion the last one seemed to be the most appropriate one. When I was developing the system and especially when I was converting the existing information to the proposed structure it occured that the chosen subdevision is o.k.

The finishing process-code consists of 10 characters:

. . . .

Position: 1 2 34 56 7890
Every code -position can have certain values:

Position 1 = [A I O I C] :

A for anorganic finishing processes
O for organic finishing processes
C for conversion coatings
An organic finishing process applies a organic material ("normal paint, decorative") on the product. An anorganic finishing process applies a non-organic material on the product like zinc, chroom, etc. A conversion coating is an anorganic coating which is created on a metalic surface as a result of the interaction between a chemical agent and the metalic surface itself.

Position 7,8,9,10 = 4{digit}4 :

Indicates the code of the finishing specification which is realised by this finishing process.

The values for the positions 2 until 6 are different for anorganic finishing processes, organic finishing processes and conversion processes.

The following can be applied for anorganic finishes:

Position 2 =][X I C I D I E I M I O I S I T] :

Position 2 indicates the kind of finishing process:
X stands for "no specification"
C stands for chemical finishing process
D diffusion finishing process
E Electroplating process
M dipping process
S Spraying
T Thermal finishing process

Position 3,4 = [XX I AL I FP I CO I PL I PW I SS I ST I ZD] :

Position 3 and 4 indicate the kind of raw material:
XX stands for no specification
ST stands for steel
AL stands for aluminium
SS stands for stainless steel
CO stands for copper
PW stands for printed wiring board
PL stands for plastic
ZD stands for zinc die castings

Position 5,6 = [XX I AL I CR I CO I KZ I LO I NI I ST I TI I TL I ZI] :

Position 5 and 6 indicate the kind of material which is being applied:
XX: no specification
AL: Aluminium
CR: Chromium
CO: Copper
KZ: Messing
LO: Lead

NI: Nikkel
OI: Oil
ST:Steel
TI: Tin
TL: Tin/lead
ZI: Zinc

The following can be applied for organic finishes:

Position 2 = [X]:

X stands for no specification

Position 3,4 = [NF I PL I ST]:

Position 3 and 4 indicate the raw material on which the finish is applied.
NF: Non ferrous material
PL: Plastic
ST: Steel

Position 5,6 = [XX]

XX stands for no specification

The following can be applied for conversion finishing processes:

Position 2 = [X I C I D I E I S I T]:

Position 2 indicates the kind of finishing process
X: no specification
C: Chemicaly applied surface
D: Dipping process
E: Electrochemical applied surface
S: Spraying process
T: Steam spraying finishing process

Position 3,4 = [XX I AL I FP I CO I PL I PW I SS I ST I ZD]:

Position 3 and 4 indicate the kind of raw material.
XX stands for no specification
ST stands for steel
AL stands for aluminium
SS stands for stainless steel
CO stands for copper
PW stands for printed wiring board
PL stands for plastic
ZD stands for zinc die castings

Position 5,6 = [CR I FX I FF I FZ I FM I OX]:

Position 5 and 6 indicate the kind of material which is being applied.
CR: Chromium
FX: Phosphate

FF: Phosphate Ferrous
FZ: Phosphate Zinc
FM: Phosphate Mangan surface

The code for a collection of finishing processes can indicate more than one collection of finishing processes. It also indicates "higher" collections of which the directly indicated collection is a part of. This enables the storing of information which is equal for a large amount of collections under ONE code.
An example will clearify the usefullness of this possibility:

Consider the code A E ST ZI0006. This code indicates zinc electroplating of steel. This code also indicates the following collections of finishing processes (even more but these are not considered by INFOFINISH):

1. X X XX XXxxxx; general information about finishing processes,
2. A X XX XXxxxx; information about anorganic finishing processes,
3. A E XX XXxxxx; information about electroplating,
4. A E ST XXxxxx; information about electroplating steel,
5. A E ST ZIxxxx; information about zinc electroplating steel,
6. A E ST ZI0006; information about zinc electroplating steel for the finishigspecification 50-0006.

Note:

1. Not every code must be filled with information. Only those codes which contain information must be present in the datafile PROC.
2. New codes can always be made and based in the system by the finishing experts who will be responsible for the system . Only the structure is fixed

4.4. Data conversion

Approximately 70 % of the information needed by the file SPEC is converted. This converted information is shown in appendix 9.
For the file PROC about 20 pages are converted which contain information of all kinds of reports containing advices and information for the product designer. (see appendix 10). This is about 30 % of the information needed by the file PROC.

Required storing capacity for the file SPEC:

The definitions of the attributes of the file SPEC show that the description of every finishing specification consists of 66 characters. SPEC must consist approximately 100 finishing specifications. Therefore a storingcapacity of 6600 characters is needed. One byte of storage in the computer (= 8 bites) can contain one character.
So SPEC requires a computer memory storage capability of approximately 7 kbyte.

Required storing capacity for the file PROC:

The datafile PROC must be able to contain approximately 100 pages of text. One page consists of ± 2000 characters.
So SPEC requires a computer memory storage capability of approximately:
2000 bytes/page x 100 pages = 200.000 byte = 200 kbyte

To give a feeling about sizes of computers: an MS-DOS Personal Computer (IBM or IBM-clone) contains 640 kbyte local memory.

Chapter 5: FURTHER DEVELOPMENT OF INFOFINISH

5.1. Specifications for the hard and software

Roughly speaking two software techniques can be used for realising INFOFINSIH: the Artificial Intelligence (A.I.) techniques or the more common techniques such as the fourth generation software. In the beginning of the project (May 1987) I considered the possibilities of using A.I. for realising INFOFINISH seriously.
This paragraph first describes why A.I.-techniques are not applied. Then a proposal is done for the hardware on which INFOFINISH will have to operate.

Artificial Intelligence

The required information system must contain knowledge possessed by a finishing expert. Some of the characteristics of a human expert are: he can work with incomplete information, he makes many estimates, he works fast by not considering irrelevant information, he makes predictions without being able to give hard reasons for these predictions, etc.
With applying Artificial Intelligence techniques one can simulate the way in which the human expert works; one can create so called expert-systems.
Expert systems work with heuristic-procedures and with algorithms. This in contradiction with the more common computer programs which only work with exactly defined algorithms; One characteristic of a conventional program is that the way of solving a problem is exactly defined.; the knowledge which is used is hidden in an algorithm. This will be a problem when knowledge must be fixed in a system with the use of common techniques : the way of solving a problem has to be known exactly and all the needed information must be present otherwise the program does not have a solution. And, when fixing expertise, this is not always possible.
So the A.I.-techniques promise a lot for basing knowledge in the future and these techniques seem to be just what we need to create 'INFOFINISH'. Unfortunately , these techniques are in a development phase nowadays.
Therefore chances are low that the objectives of this project will be reached when INFOFINISH will be created with the use of A.I.-techniques.

Proposed Hardware

Mainly two kinds of hardware configurations are possible in which the information system INFOFINISH can operate:

1. A central computer library to which workstations of all designers have access.
2. On stand-alone workstations. INFOFINISH will be based on floppy disks. These can be sent to all the potential users in the world where the user can fill his computer with the system INFOFINISH.

Updating the system INFOFINISH with the first configuration is much easier than with the second configuration because there is only one version of INFOFINISH. Updating the system INFOFINSH with the second configuration is difficult or even impossible. This is related with the high rate of function changes inside Xerox. When a new version of INFOFINISH is issued this version must be put on new floppy disks and it will be sent to all users. As a result of the high rate of function changes one is never sure that the right person recieves the new updated version. After a few years it is quite possible that e.g. the second and the fourth version of INFOFINISH are in use simultaneously. This is very bad for the reliability of the information system.

I propose to develope the information system INFOFINISH on the first configuration.

This report-version does not contain a describtion of the different computer configurations and hardware in Rank Xerox.

Which configuration and which hardware is going to be used will have to be discussed with the product designers. Nevertheless, on behalf of what I described above I propose to base the system INFOFINISH in a library on the IBM-mianframe.

All kinds of software can run on the IBM-mainframe e.g. Pascal, Fortran, Basic, Focuss, IFPS, Cobal etc.

5.2. Costs and Time needed for realising INFOFINISH

Development costs:

If management decides to continue this project it would take approximately 7 months for a computer programmer to realise the project INFOFINISH (see appendix 11). This time is required for the resulting SDM-phases which will have to be carried out: the Programming phase, the Testing phase,the Conversion phase and the System Implementation phase.
Assume a programmer costs Fl 100.- an hour then realising the system INFOFINISH will cost:
(7 months) x (30 days/month) x (8 hours/day) x (Fl 100.-/hour) = Fl 168,000.- = $ 67,200.-

Maintanance costs

In literature the maintanance costs of the software of a computerprogram are calculated as being 5 % of the total investmentcosts of this information system. This would mean that the maintanance costs for INFFOFINISH amount to approximately $ 3000.-.
One may say that the calculated 5 % is too low because in INFOFINISH the present information also has to be updated. I do not agree; I assume that these updating costs for the information in INFOFINISH are just as high as the costs made by a finishing expert nowadays for advicing the product designers.

5.3. Requirements for succesfull implementation

Involvement of the primary user in this project is a must. The reasons are:

- to recieve feedback on the proposals for the information system from the primary users; so also for the suggested hard and software to be used;
- to get more information on the way the designers now receive their information about the finishing processes.
- in order to reach all the potential advantages of INFOFINISH it is necessary to oblige the designer to use it. The usage of the system, and other future system equal to it, must be arranged in a well organised design procedure.

Chapter 6: DISCUSSION

The technical design of a the required information system is ready. This design is a frame which gives opportunities to meet the requirements mentioned in chapter 3. Firstly, INFOFINISH is able to give the designer the 5 types of sufficient information because its structure gives these oppertunities. The information given by INFOFINISH can always be replenished. Secondly, whether INFOFINISH meets the other 7 requirements or not, is mainly a matter of good programming.

The ultimate question is: "Is it wise to continue this project ?"

To give an answer to this question I will discuss the different advantages and disadvantages related with the development and usage of INFOFINISH. I will do this by firstly passing in revue the objectives of this project;

The first objective

The first objective was: "a reduction in costs during the production and maintanance phase of a copier". This is the result of an expected lower change rate in parts and tools and cheaper finishing processing costs.
In paragraph 2.4.2. it occured that the finishing experts had the opinion that the tuning of the product designs to the production requirements is bad. The conclusion of the survey I did was that it costed RXV the last 2 years $ 50,000.- strictly as a result of the presence of product designs which do not attune to the production requirements and therefore had to be changed.
So usage of the system can result in a lower change rate.
The finishing experts estimate that also cheaper finishing processing is possible.

Developing INFOFINISH will cost approximately $ 67,200.-

The conclusion of these figures is that the return on investments amounts to approximately 3 years.
On behalf of these data I think a cost-reduction in the production and maintanance phase is possible as a result of the designers using INFOFINISH but it will be abolished by the costs of developing INFOFINISH.

The second objective

The second objective of this project is to gain a decrease in total throughputtime.
Usage of INFOFINISH can reduce the throughputtime in the production phase because the product designs will be better tuned to the finishing processes.
Decrease of throughputtime in the Design and Development Phase of a copier is also possible as a result of the better availability of information related with the finishing - processes. The supply of information about the finishing processes in the current situation is very bad; see paragraph 2.4.. This can be tremendously improved with the usage of INFOFINISH because INFOFINISH :

- gives all the needed information about the finishing processes
- INFOFINISH gives this information in an efficient way; it only gives information which is interesting for the user. So the user does not have to look through thick reports or manuals in order to find the information he needs.

The third objective

The third objective was to improve the quality of the surface of the finished product.
I am not a finishing expert so I can not determine the quality of the average finishing . I can only trust in the opinion of the Xerox finishing experts that the average qualtiy of a finishing can be improved. By using INFOFINISH the product designer has at his disposal the information about the finishing processes needed to attune his product design to the finishing processes. This is a great difference with the current situation.
So, usage of INFOFINISH has the capability to improve the quality of the surface of the product.

The fourth objective

The fourth objective was to have better feedback possibilities. This is certainly the case when INFOFINISH is operational. All the designers can efficiently be informed about new finishing technologies or experiences according the finishing processes.

The fifth objective

The fifth objective of this project is to get a better insight in the problems which will occure whencreating these kinds of information systems. The only knowledge on this point now is that it is possible to store the information about the finishing processes in an efficient and usefull way.
A usefull insight will occur when this information system is discussed with the designers and implemented.

Another advantage not mentioned as an objective in the beginning of this project are the costreductions in the Design and in the Development phase. This is the result of the potential decrease in throughputtime in the Design and in the Developement Phase.

A good reason for developing INFOFINISH is the absence of a CCM- "Finishing". The way in which the information about the finishing processes is organised is bad at this moment. Introducing INFOFINISH can structure the supply of information related with the finishing processes. The Xerox finishing team may be seen as something like a CCM-"Finishing" but it does not have the same authorities.

Chapter 7: CONCLUSION AND RECOMMENDATION

Conclusions:

1. I finish my work in RXV by proposing a design for an information system which is described in my task as:
   "Information system with information about the finishing processes for usage by the product designer. This sytem must help the designer to attune his product to the finishing -processes. It will be based on computers".

   This design provides a frame which gives oppertunities for realising the ultimate objectives of the project which is started.

2. If management decides to continue this project it would take approximately 7 months for a computer programmer to finish the project .

Recommandations:

1. I do recommend RXV to continue the project and realise INFOFINISH because I expect the following results of a usage of INFOFINISH:

   1. Decrease in total throughputtime of a copier.
   2. Quality improvement of the finished surfaces of the products.
   3. Efficient possibilities to feedback infromation about the finishingprocesses to the product designers.
   4. Experience with developing these kinds of systems.
   5. Costreductions in the Design and Development phase.

   If this project is continued then the return on investments is expected to be 3 years.

2. Implement the information system on the IBM-mainframe in England or U.S.

3. Involvement of the user in this project is a must from now on in order to:
   - recieve feedback on the proposals for the information system from the primary users; so also for the suggested hard and software to be used;
   - get more information on the way the designers now receive their information about the finishing processes.
   - reach all the potential advantages of INFOFINISH it is necessary to oblige the designer to use it. The usage of the system, and other future system equal to it, must be arranged in a well organised design procedure.

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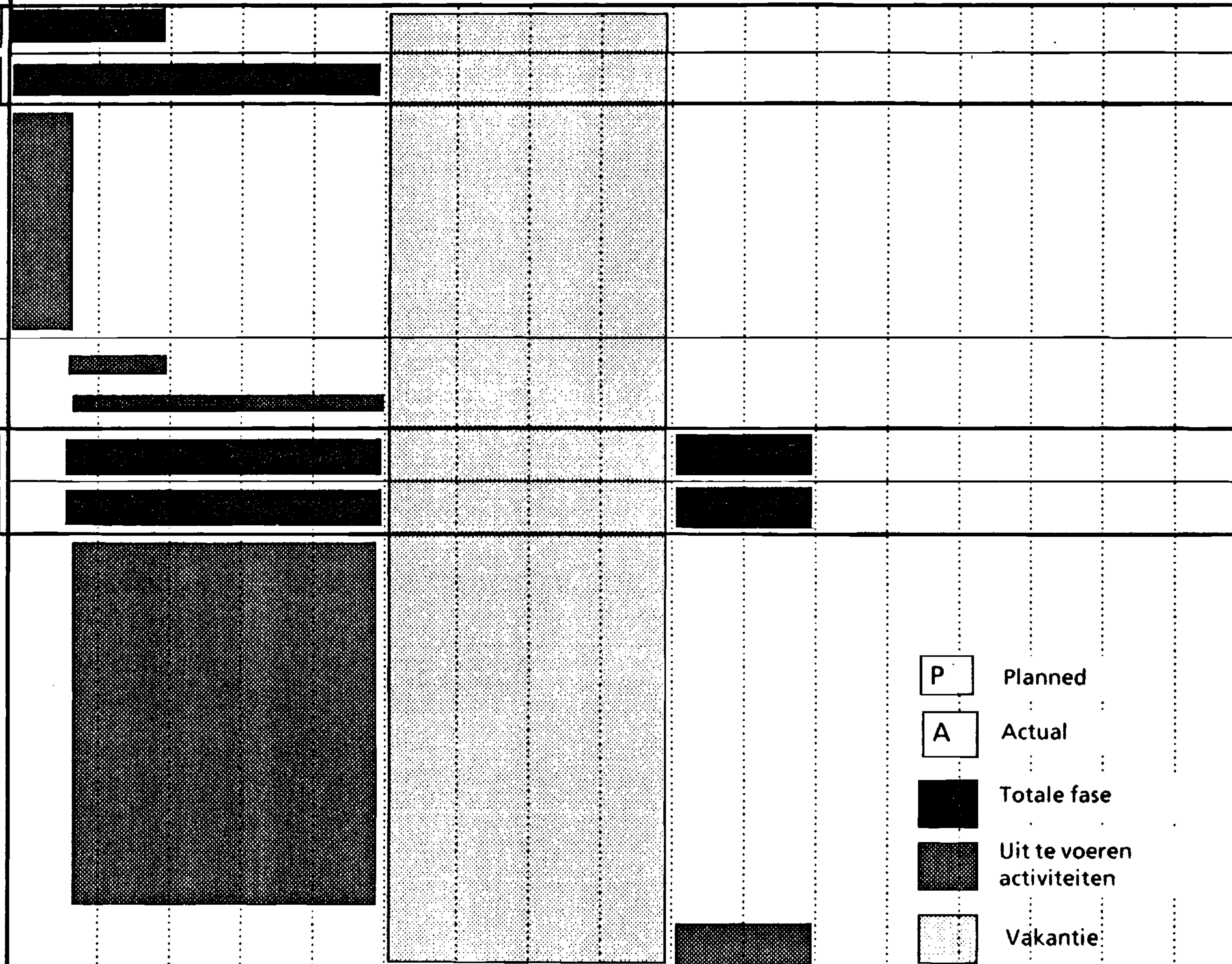
CONTENTS

RANK XEROX	BARCHART PLANNING FINISH- PROCES INFO SYSTEEM	date: 12 juni 1987 iss.by: Mark Mathijssen page: 1 iss.: 2

description activity.

reporting date: 1987
juni, juli, augustus, september, octob.
19,06 26,06 03,07 10,07 17,07 24,07 31,07 07,08 14,08 21,08 28,08 04,09 11,09 18,09 25,09 02,10



1. Definitie studie (P / A)

1. Gewenste eindresultaat van dit project
2. Doel van dit project
3. Eisen aan het gewenste eindresultaat
4. Werkwijze en planning van dit project
5. Te raadplegen informatie-bronnen
6. Beschrijving van de huidige situatie op het gebied van de informatievoorziening omtrent de finishprocessen
7. Acceptatie rapport (P / a)

2. Functioneel ontwerpen van het proces informatie-systeem (P / A)

1. Creeren raamwerk waarbinnen systeem moet kunnen functioneren.
2. Bepalen welke informatie het systeem moet bezitten
3. Verdelen van het systeem in subsystemen
4. Beschrijven in- en uitvoer van subsysteem
5. Procesbeschrijvingen
6. Ontwerpen van gegevens structuur
7. Specificeren benodigde faciliteiten
8. Samenstellen rapport 'functioneel ontwerp'
8. Acceptatie rapport

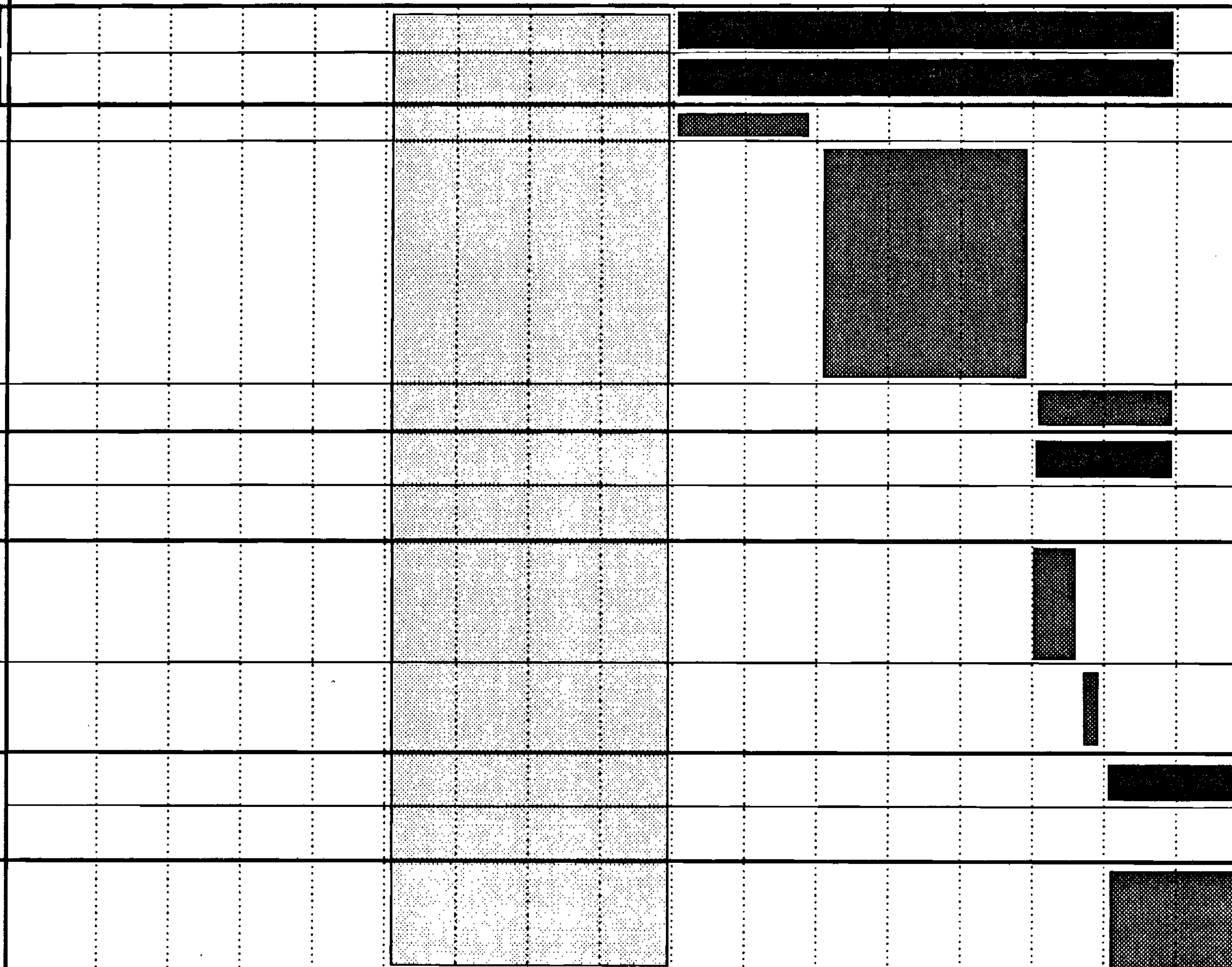
RANK XEROX	BARCHART PLANNING FINISH-PROCES INFO SYSTEEM	date: 12 juni 1987 iss.by: Mark Mathijssen page: 2 iss.: 2

description activity.

reporting date: 1985

juni 19,06 26,06 — juli 03,07 10,07 17,07 24,07 — augustus 31,07 07,08 14,08 21,08 28,08 — september 04,09 11,09 18,09 25,09 — octob. 02,10

3.	Technisch ontwerpen van het informatie-systeem	P / A
	1. Conversie van gegevens 2. Contact met gebruikers en I.S. 3. Ontwerpen procedures 2. Formaliseren alle in- en uitvoer 3. Ontwerpen opslagstructuur 4. Programma specificties en schema 5. Specificeren te gebruiken software 6. Maken van gedetailleerd programmeer en test-plan 7. Samenstellen rapport 8. Acceptatie rapport	
4.	Herbezinningsfase	P / A
	Beslissen over doorgaan met de gestelde planning of nader uitwerken van de rapporten	
	Acceptatie van de beslissing	
5.	Bestudering hard en software	P / A
	Bstuderen hard- en software Nadere detaillering van de opgestelde planning	



RANK XEROX	BARCHART PLANNING FINISH-PROCES INFO SYSTEEM	iss.by: Mark Mathijssen page: 3 issue: 2

description activity.

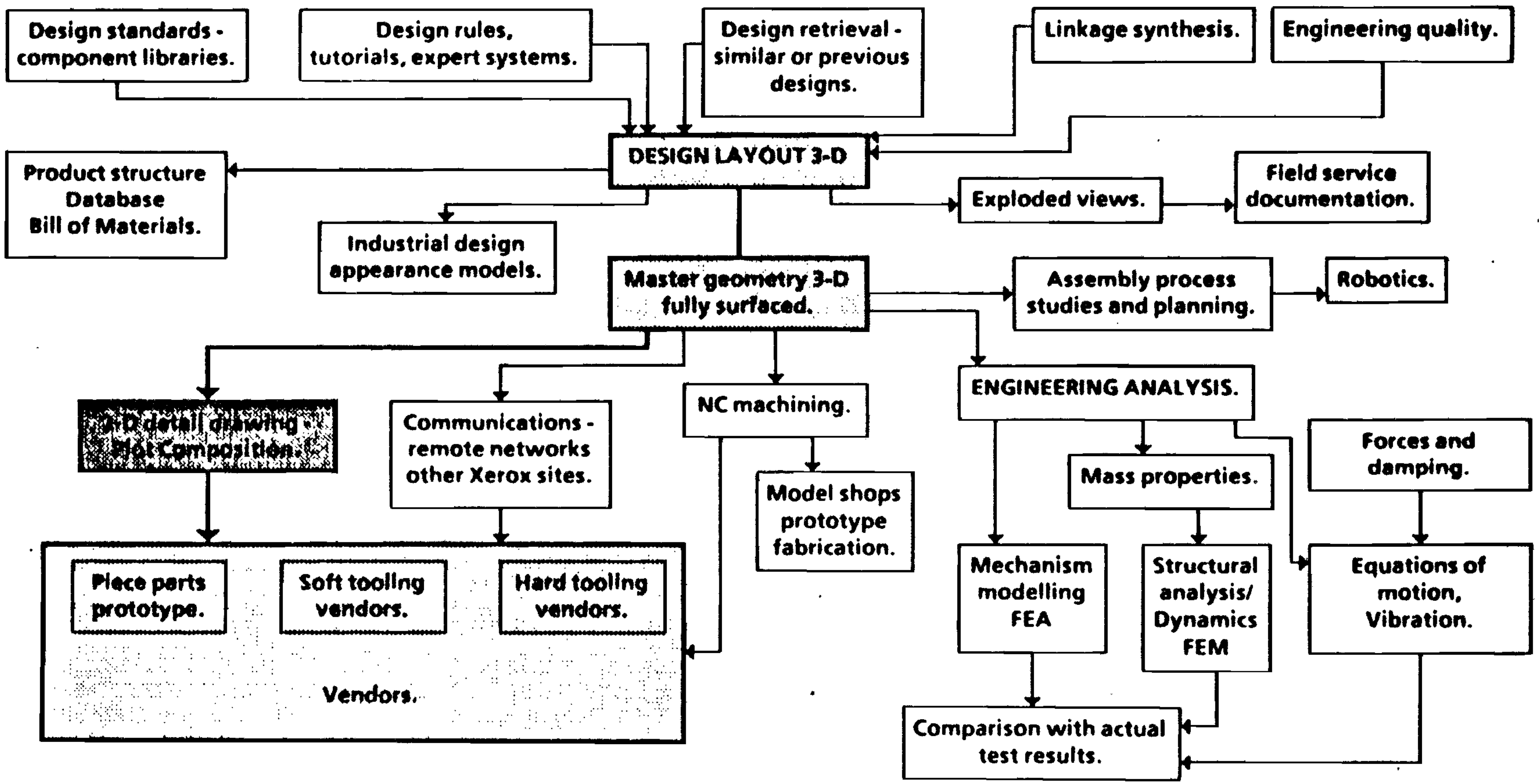
reporting date: 1987

october, november, december, januarie

09,10 16,10 23,10 30,10 06,11 13,11 20,11 27,11 04,12 11,12 18,12 25,12 01,01

No.	description activity	
5.	Bestuderen hard en software	
6.	Programmeren	P
		A
	1. Detailleren van programma specificaties 2. Coderen programma specificaties en schema's 3. Testen 4. Completeren programma specs	
7.	Testen van het prottype	P
		A
8.	Conversie en invoering van gegevens en programma	P
		A
9.	Systeembeheer en onderhoud	P
		A
		P
		A
		P
		A
		P
		A

4. CAD/CAM/CAE "ROADMAP".



Presented by Martin B. Clutterbuck.

Appendix 5: Reasons for selecting the finishing processes

Previous to the beginning of this project RXV knew that it wanted a survey on the possibilities and usefulness of offering an information system to the designers: this system should contain information about the production and it should help the product designer to attune his designs to the requirements of the production. For this reason RXV would like to build a prototype of the ultimate system with only information about a certain kind of productionprocess.This resulted in giving me the task to start this project. This ends up in an informationsystem which contains information about the finishing processes for usage by the designers.

In this appendix I will describe why I advised RXV to select the information about the finishing processes and not information about other kinds of processes.

In order to reach the obejectives of this project, the requirements for the kind of production process which had to be selected for this project were:
1. The expertise which belongs to the chosen production process should be present inside RXV.
2. RXV should also feel the advantages of the informationsystem.
3. The information system should be interesting for the designers.

The following kinds of production processes meet these requirements:
- assembly processes; these processes are present in RXV so the expertise and potential advantages of a system with information about the assembly processes are there.
- finishingprocesses; same as for the assembly processes
- processes related with sheetmetal; these processes are not present in RXV but the headquarter of the CCM sheetmetal of Xerox is. So the sheetmetal expertise is present in RXV and it could feel the advantages of the system.

I took into account the following remarks:

1. The information about the finishing processes is better to overlook than the information about the assembly processes.
2. The feedback of information about the assembly processes is already partly being realsied with the information system "Design For Assembly"(D.F.A.) which is now in use in Rank Xerox.
3. The D.F.A.-program only gives information about the assembly processes. The advices given by the D.F.A.-program to improve the "assembly processability" may be very wrong for the other processes which will have to process the product. Therefore it seems a logical and useful step to broaden the feedback of production related information with information about other production processes.
4. Information about processes related with sheetmetal is already being put in a computer based informationsystem by the Rochester Institute for Techology (R.I.T.).
5. There is no CCM-"Finishing". So the supply of information about the finishingprocesses to the productdesigners is not well structured.

Remark 4 makes the processes related with sheetmetal less interesting. Remark 1,2 and 3 make the assembly processes less interesting. Remark 5 is a reason for selecting the finishingprocesses. Therefore the information about the finishing processes is selected to be put in an information system.

APPENDIX 7:

EXACT WORKING OF THE INFORMATIONSYSTEM INFOFINISH

Contents:

7.1. Infromation System Documentation Techniques

As already mentioned in chapter 3 of part I, the the information system INFOFINISH is developed according to the System Development Methodology SDM. This methodology seemed to be very helpful in developing INFOFINISH but I still had problems to find the right documentation techniques by which I could describe the system's Functional Design and the system's Technical Design. These problems seem to be common in the world of software development. I myself had the same experience in my last practical training (at the Ergon Bedrijven in Eindhoven) were I have developed a computer program until userreadiness.
Mr Doorschot pointed me at the techniques proposed by Yourdon. After reading literature [7] I could find myself in what Yourdon writes about in-abilities of the commonly used flowcharts and other currently used techniques.
Yourdon promotes so called ' structural techniques'; according to him this is the 'collection of procedures and concepts that generally will double the productivity and effectiveness of a data processing department'. The elements that make up this structural revolution are:

- Structured Analysis	- Structured programming
- Top down design	- Chief Programmer Teams
- Structured Design	- Program Librarians
- Structure Charts	- Structured Walkthroughs

See lit [7] for a more extended description of the techniques proposed by Yourdon. The documentation techniques which can be used with these structured techniques and which are proposed by Yourdon are the Data flow Diagram, HIPO hierarchy charts ,Structure Charts, and Nasi Shneiderman charts.

I have used the Dataflow Diagram and the HIPO hierarchy Chart to document the Functional Design of INFOFINISH . See lit[6] for the Functional Design report. With this report I could inform all parties involved about my plans for INFOFINISH. I could check my ideas and make some little changes in both the data structure and the system's design. It is not interesting anymore to read this report since I have changed the working of INFOFINISH during the Technical Design Phase.

In this appendix the reader will find a complete description of the of the information system INFOFINISH. I do this by giving a general description of INFOFINISH, by describing the essence of INFOFINISH and by specifying the data structure needed and used by INFOFINISH . In appendix 5of this report I describe INFOFINISH in a formal way by using Pseudocode and a Structure Chart.

<u>Pseudocode</u>

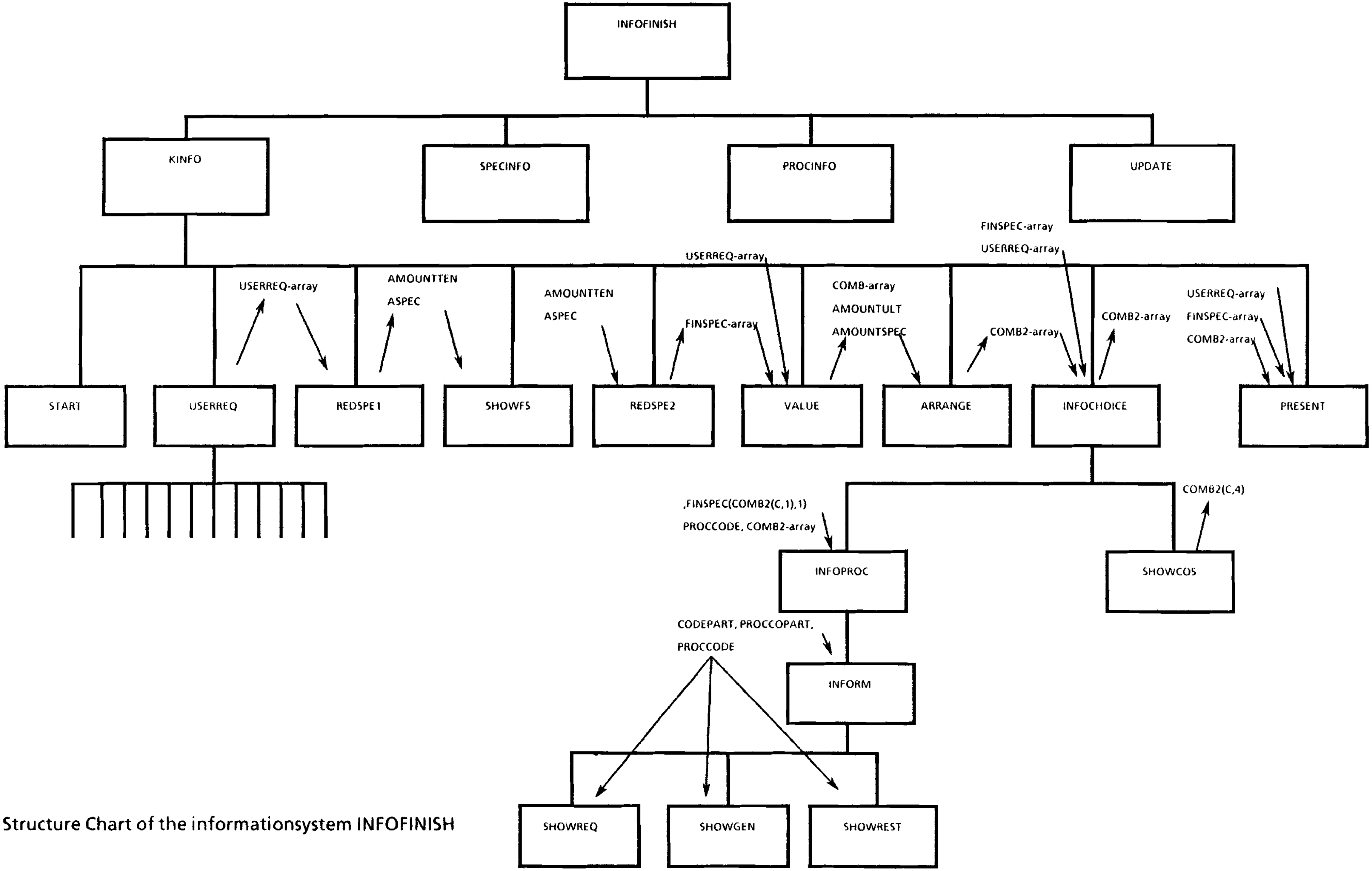
Pseudocode can be defined as "narrative documentation" constructed from combinations of

- simple, imperative sentences, written in English, containing a single, transitive verb and a singlenon-plural object
- IF-THEN-ELSE constructs
- DO WHILE constructs
- other appropriate extensions to structured programming

Pseudocode is reasonably well organised and precise, and yet informal enough to be intelligible to non-programmers. Since it does not require a flowcharting template, pseudocode can be written quickly and easily.

<u>Structure Charts</u>

A Structure chart shows the hierarchy of the existing subroutines in an information system and it also has to ability to show occasional procedural detail without getting bogged



Structure Chart of the informationsystem INFOFINISH down in detail. It does not show the precise sequence in which the subroutines will be executed, nor any detailed decisions or loops, nor any of the detailedprocessing steps inside a subroutine. It does provide a good overview of a large information system.

The exact working of the information system INFOFINISH is described by means of a structure chart (on the next page) and a description of every subroutine.

Descriptions of the subroutines:
description of a subroutine describes:

- the input in the subroutine;
- the output of the subrouitne;
- the function of the subroutine;
- the working of the subroutine:
  the working is shown with the aid of a pseudocode which is quite easy to understand. The italics written sentences are not functional instructions for the computer but are ment to explain certain actions.

Description of the used data:

The main data which are processed by INFOFINISH is described at the end of this appendix. This main data are also shown on the structure chart.

Main program INFOFINISH

Function:

The informationsystem INFOFINISH can give:
1. Information about interesting finishingspecifications and -processes.
2. The choice of the best finishingspecification and -process according to the input given by the user.
3. Alternative choices of finishingspecifications and -processes according to the input given by the user.

Working :

BEGINSUBR

POSKIIN = 100; *indicates where the programme can continue*
DO give general information about this informationsystem

DO WHILE POSKI EQ 100
BEGIN

WRITES The user now can choose one of the following options:
1.Getting help with choosing the best finishingspecification for his individual purpose.
At the same time he will get all kinds of information about the finishingspecifications and the finishingprocesses which are important for a designer to know.

2.Getting information about finishingspecifications

3.Getting information about finishingprocesses
4.Log off

5.Updating the informationsystem (only if the user knows the password).

IF option 1 THEN DO KINFO
The function of the subroutine KINFO is to give:
1. Information about interesting finishingspecifications and -processes.
2. The choice of the best finishingspecification and -process according to the input given by the user.
3. Alternative choices of finishingspecifications and -processes according to the input given by the user.
IF option 2 THEN DO SPECINFO
The function of this subroutine is to give information about the finishingspecifications. The user can ask for information about one single finishingspecification but also about certain finishingspecifications which meet to the constraints made by the user himself.
The information about a finishingspecification contains all the values which this finishingspecification has for all the possible attributes of a finishingspecification plus some remarks (if present).
IF option 3 THEN DO PROCINFO

The function of subroutine PROCINFO is to give information about a choosen finishingprocess or about a certain collection of finishingprocesses. This information can contain general information about the process(es), absolute requirements of the process(es) and wishes of the process(es). The user is also being told what happens if he doesn't meet to these wishes.

IF option 4 THEN DO POSKI = 999

IF option 5 THEN DO UPDATING

With this subroutine thefiles SPEC and PROC can be updated

ENDWHILE

ENDSUBR

Subroutine KINFO

Input:

The user requirements for the ultimate finishing.charasteristics of the product design.

Output:

Information about interesting finishingspecificationsand -processes.
The choice of the best finishingspecification and - process according to the input given by the user.
Alternative choices of finishingspecifications and - processes according to the input given by the user.

Function:

The function of the subroutine KINFO is to give:
1. Information about interesting finishingspecifications and -processes.
2. The choice of the best finishingspecification and -process according to the input given by the user.
3. Alternative choices of finishingspecifications and -processes according to the input given by the user.

Working:

BEGINSUBR

<u>DO WHILE POSKI NEQ 999</u>

BEGIN

<u>IF POSKI EQ 100 THEN</u>
  BEGIN
  DO START
  POSKI = 200
  ENDIF

<u>IF POSKI EQ 200 THEN</u>
  BEGIN
  DO USERREQ

USERREQ asks the user what values he requires for the charasteristics of the ultimate finish. It is possible for the user to require more then 1 value for a certain attribute; USERREQ then creates an "ultimate situation" for every possible combination of values for the finish-attributes.
USERREQ also asks the user how importanct the charasteristic is.
All these values are being put in the mentioned array USERREQ.

So the array USERREQ contains all the data belonging to different ultimate situations.

  POSKI = 300
  ENDIF

```
IF POSKI EQ 300 THEN
        BEGIN
        DO REDSPE1
                Absolute required attributes have an importance of 5.
                The subroutine REDSPE1 selects those numbers of thefinishingspecifications
                given in the file SPEC which have the same values for the absolute required
                attributes.
        POSKI = 400
        ENDIF

IF AANTTIEN = 0 THEN
        BEGIN
        WRITES      "You did not meet the claim to attech the importance "5" to at least
                    ONE finishing character. Therefore you will have to specify your require-
                    ments according to the ultimate finish again.
        POSKI = 200
        ENDIF

IF POSKI NEQ 200 AND there are no finishing specifications left THEN
        BEGIN
        WRITES      Tell the user that there are no finishingspecifications of which the
                    attributes are equal to the attributes required by the user and which
                    had an importance worth "5".
                    The user now can choose between the following options:
                    1. Find out which finishing specifications nearly meet to his
                    requirements
                    2. To specify new requirements for the attributes of the ultimate finish
                    3. To stop with this subroutine and go back to the main menu

        IF option 1 THEN
                BEGIN
                DO SHOWFS
                        The subroutine SHOWFS can help the user in finding out which
                        finishingspecifications nearly meet his requirements.
                WRITES      The user now can choose between the following options:
                            1.To specify new requirements for the attributes of the ultimate
                               finish
                            2.To stop with this subroutine and go back to the main menu

                            IF option 1 THEN POSKI = 200
                            IF option 2 THEN POSKI = 999
                ENDIF

        IF option 2 THEN POSKI = 200
        IF option 3 THEN POSKI = 999

IF POSKI = 400 THEN
        BEGIN
        DO REDSPE2
                The finishingspecifications selected by REDSPE1 are shown to the user. (These
                the finishingspecifications whose number is in ASPEC(AMOUNTTEN,*)). The
                user will have the possibility to delete one or more finishing specifications
                which are not interesting for him.
        POSKI = 500
        END
```

<u>IF POSKI = 500 THEN</u>
BEGIN
WRITES Those finishingspecifications which are left. Then ask the user whether he agrees with the program to continue with these finishingspecifications. The user now can choose between the following options:
1. Agree with the selected finishingspecifications
2. Re-do the latest reduction made in REDSPE2
3. Specify new requirements for the attributes of the ultimate finish

IF option 1 THEN POSKI = 600
IF option 2 THEN POSKI = 400
IF option 3 THEN POSKI = 200

<u>IF POSKI EQ 600 THEN DO</u>
BEGIN
DO VALUE
The subroutine VALUE gives a valuation to every possible combination of finishingspecification and ultimate situation and fils the array COMB(,*) with this value.*
DO ARRANGE
This subroutine selects 3 interesting combinations from all the existing combinations:
- 2 combinations with a ultimate situation number equal to 1 with the highest values of all the combinations with a ultimate situation number equal to 1.
- 1 combination with a ultimate situation number not equal to 1 with the highest value of all the combination with a ultimate situation number not equal to 1.
POSKI = 700
ENDIF

<u>IF POSKI EQ 700 DO</u>
BEGIN
WRITES The selected combinations . Ask the user if it is all right to go on with the given combinations. The user now can chose between the following options:
1. Agree
2. Not agree; again do the last reduction in combinations
3. Stop with this subroutine and go back to the main menu.

<u>IF option 1 THEN</u> POSKI = 800
<u>IF option 2 THEN</u> POSKI = 700
<u>IF option 3 THEN</u> POSKI = 999
ENDDO

<u>IF POSKI EQ 800 THEN DO</u>
BEGIN
DO INFOCHOICE
DO PRESENT
WRITES The end of the program is reached. The user has the following options:
1. Go back to the main menu
2. See again the the information about the interesting finishingprocesses
3. Specify new requirements for the attributes of the ultimate finish and start again

```
    IF option 1 THEN POSKI = 999
    IF option 2 THEN POSKI = 700
    IF option 3 THEN POSKI = 200
    ENDIF

ENDWHILE

ENDSUBR
```

Subroutine START

The

In this subroutine all kinds of information which is interesting for the user can be placed.

Sunroutine USERREQ

Input:

The user- requirements for the charasteristics of the ultimate finish. These attributes are:
1. Thickness increase and importance of thethickness increase.
2. Hardness and importance of the hardness.
3. Abrasion resistance and importance of the abrasion resistance.
4. Corrosion resistance and importance of the corrosion resistance.
5. Raw material and importance of the raw material.
6. Color/description and importance of the color/description.
7. Color & Appearance-nummer and importance of the color & Appearance-nummer.
8. Reflectivity and importance of the reflectivity and importance.
9. Dielectric Strength and importance of the Dielectric Strength.
10.Insulation resistance and importance of the insulation resistance.
11.Paper friction and importance of the paper friction.
12.Greasing property and importance of the greasing property.
13.High temperature resistant and importance of the high temperature resistant.
14.Flexibility and importance of the flexibility.
15.Elongation and importance of the elongation.

Output:

The USERREQ-array which containS the user requirements.

Function:

USERREQ asks the user what values he requires for the charasteristics of the ultimate finish. A socalled 'ultimate situation' is made up out of these requirements. The user has the possibilty to require more then 1 value for a certain attribute; USERREQ then creates an "ultimate situation" for every possible combination of values for the finish-attributes.
USERREQ also asks the user how important the charasteristic is.
All these values are being put in the mentioned array USERREQ.

So the array USERREQ contains all the data belonging to different ultimate situations.

Working:

BEGINSUBR

TOTAL = 1; *Indicates the total amount of new stituations created.*

BEGIN

DO show all the different attributes of a finish on the screen. Let the user chose which attributes are important for him.(for every attribute there is a subroutine which:
- can give information about this attribute
- gives the user the possibility to give the reequired values for this attribute)

I will now give a very global description on how the rest of this subroutine could work;

```
IF choice = thicknessincrease THEN
        BEGIN
        DO INFOTHICKNESSINCREASE
        END

IF choice = abrasionresistance THEN
        BEGIN
        DO INFOABRASIONRESISTANCE
        END
.
.
.
.
.
.
.
.(etc. until the character 'Elongation':)
IF choice = elongation THEN
        BEGIN
        DO INFOELONGATION
        pos = 100
        END


DO    make the importancies of those attributes which are not important for the user
      equal to 0

END

ENDSUBR
```

In the end the array USERREQ(U,I,J) is filled with different ultimate situations and with the different importancies belonging to the different attributes;

- U stands for the number of the ultimate situation
- I indicates the numbers of the attribute mentioned in the input
- J indicates the importancy of the attribute indicated by I

Subroutine INFOABRASIONRESISTANCE

Input:

TOTAL; contains the amount of ultimate situations made until now
USERREQ-array;

Output:

TOTAL; adapted to the new situation
USERREQ-arrays; adapted to the new situation

Function:

The function of the subroutine is to:
- give information about the attribute "abrasionresistance"
- give the user the possibility to give input for the the required values for this attribute

Working:

BEGINSUBR
POSABR = 100

DO WHILE POSABR = 100
BEGIN

WRITES The abrasionresistance of a coating can have one of the following values: 1,2,3,4,5.

The value 1:
Indicates that there are no special requirements for the abrasionresistance of the coating

The value 2:
Indicates that the coating has to meet the requirement that there will be no more then 150 gr loss for /////?????????????
This is a normal requirement for decorative finishes.

The value 3:
Indicates that the coating has to meet to the requirement that there will be no more then 50 gr. loss
This requirement is often given for surfaces beside the paperpath; e.g. a zinc-coating.

The value 4:
Indicates that the coating has to meet to the requirement that there will be no more then 25 gr. los?????????????????
This is very high requirement for the abrasionresistance of a coating; e.g. a teflon- coating

The value 5:

This is an extreme high requirement for the abrasionresistance of a coating; e.g. a nickel or a chromium ???????-coating

Please type in the value(s) you require for the abrasionresistance.
Type 'i' for more information

IF i is typed in THEN DO
BEGIN
WRITES You have the possibility to type in more then one value. I can imagine you would like to do this when you are not sure of your requirement. By typing in more then one value you will be able to find out what will happen when your requirement will be higher or lower.
For every value for the abrasionresistance another socalled "ultimate situation" will be created. A ultimate situation contains the values for every attribute of the ultimate finish; one value for every attribute. When you for example type in 2 values for the abrasionresistance then 2 ultimate situations will be created with only a different value for the abrasionresistance. When you allready have typed in 3 other values for another attribute I will then make (2 x 3 =) 6 ultimate situations.
I will consider every ultimate situation on its own. In order to avoid to much work for me I give you the following restriction:
(amount of values for the first attribute) x (amount of values for the second attribute) x .... x (amount of values for the fifteenth attribute) < = 25

Please type in the required value(s) with a comma in between. The first value will be considered as the most relevant one and will be considered better then the other values (if present)
ENDIF

READ de first value; call it USERREQ((1,3)

T = 2

DO WHILE T< = TOTAL
Firstly the allready excisting ultimate sitiuations will be filled with the first value of the abrasionresistance
BEGIN
USERREQ(T,3) = USERREQ(1,3)
T = T + 1
ENDWHILE

TOTALOLD = T *(= TOTAL at this moment); So TOTALOLD indicates the amount of ultimate situations before this subroutine was called.*
IF there are more then one values for the abrasionresistance THEN
BEGIN
The new ultimate situations will have to be made.
READ the amount of values typed in; call it AMOUNTVAL
TOTAL = TOTAL x AMOUNTVAL; *the new amount of ultimate situations equals the old amount multiplied by the amount of values typed in for the abrasionresistance*

```
            IF TOTAL > 25 THEN
                  BEGIN
                  WRITES      You have TOTAL ultimate situations until now so you did
                              not meet to the restriction 'no more then 25 ultimate
                              situations'.
                              Please type in new value(s).
                  TOTAL = TOTAL/AMOUNTVAL
                  POSABR = 100
                  END
            ELSE
                  BEGIN
                  J = 1
                  DO WHILE as long as there is a value for the abrasionresistance
                        BEGIN
                        READ the next value for the abrasionresistance ABRAS
                        I = 1
                        DO WHILE I<TOTALOLD
                              BEGIN
                              USERREQ((JXTOTALOLD) + I,3) = ABRAS
                              USERREQ((JXTOTALOLD) + I,1) = USERREQ(I,1)
                              USERREQ((JXTOTALOLD) + I,2) = USERREQ(I,2)
                              I = I + 1
                              ENDWHILE
                        J = J + 1
                        ENDWHILE
                  ENDELSE
            POSABR = 200
            ENDIF
      ENDWHILE

DO WHILE POSABR = 200
      BEGIN
      WRITES      Type in please how important the abrasionresistanceis for you;
                  '0' means not important at all, '5' means absolutely required.
                  Hereby there is the following claim: at least ONE attribute must have an
                  importance of 5.
      READ The importance of the abrasionresistance; call it USERREQ(1,3,1)
      ENDWHILE

ENDSUBR
```

Subroutine REDSPE1

Input:

USERREQ-array

Output:

ASPEC(I,J); ASPEC (I,*) contains the finishing specification numbers which have I times the same value for the absolutely required values for the absolutely required attributes.
AMOUNTTEN; amount of attributes of which the values are absolutely required

Function:

Absolute required attributes have an importance of 5.
The subroutine REDSPE1 selects those numbers of thefinishingspecifications given in the file SPEC which have the same values for the absolute required attributes.

Working:

```
BEGINSUBR

DO   give a value to AMOUNTEN = 'amount of attributes of which the values are abso-
     lutely required'

IF AMOUNTTEN NEQ 0 THEN
     BEGIN
     I = 1;  I stands for the amount of attributes which have the same value as the
             absolutely required values for the absolutely required attributes

     DO WHILE I< = AMOUNTTEN
          BEGIN
          DO WHILE there are records in SPEC
               J = 1; just indicates another fin.spec.number
               BEGIN
               IFthe finishingspecification has I-TIMES the samevalues for the
               absolutely required attributes THEN
                    BEGIN
                    ASPEC(I,J) = finishingspecificationnumber
                    J = J + 1
                    ENDIF
               ENDWHILE
               I = I + 1
          ENDWHILE
     ENDIF

ENDSUBR
```

Subroutine SHOWFS

Input:

ASPEC(I,J); ASPEC (I,*) contains the finishing specification numbers which have I times the same value for the absolutely required values for the absolutely required attributes.

Output:

The finishingpsecifications which have I times the same values as the absolutely required values for the absolutely required attributes.

Function:

The subroutine SHOWFS can help the user in finding out which finishingspecifications nearly meet his requirements.

Working:

BEGINSUBR

POSSH = 100

I = AMOUNTTEN-1

DO WHILE I>0 AND POSSH NEQ 999
BEGIN
WRITES The user has AMOUNTTEN attributes of which the given values are absolutely required. The following finishingspecifications do have I-times a attributes which have the same value as the absolutely required values.

WRITES The finishingspecifications whose numbers is in ASPEC(I,*)

WRITES Ask the user if he would like more information;
1. More information
2. No more information

IF option 2 THEN POSSH = 999
ELSE I = I-1

ENDWHILE

ENDSUBR

Subroutine REDSPE2

Input:

USERREQ-array
ASPEC(AMOUNTTEN,*); numbers of the finishingspecifications of which the values are equal to all the absolutely required values.

Output:

FINSPEC-array; these arrays describe the finishingspecifications which will be considered in the rest of the program. See for a description of the data the end of this appendix.

Function:

The finishingspecifications selected by REDSPE1 are shown to the user. (These are the finishingspecifications whose number is in ASPEC(AMOUNTTEN,*)). The user will have the possibility to delete one or more finishing specifications which are not interesting.

Working:

BEGINSUBR

WRITES The finishingspecifications whose number is inASPEC(AMOUNTTEN,*))

DO give the user the possibility to delete one or more finishing specifications he doesn't want to be considered in the rest of the program.

DO Fill the FINSPEC-array

ENDSUBR

Subroutine VALUE

Input:

USERREQ-array
FINSPEC-array

Output:

COMB(*,*);
- COMB(C,*): number of the combination of finishingspecification and ultimate situation
- COMB(*,1): number of the finishingspecification
- COMB(*,2): number of the ultimate situation
- COMB(*,3): valuation of the combination
- COMB(*,4): costindication of the combination

AMOUNTULT; amount of ultimate situations
AMOUNTSPEC:amount of selected finishingspecifications (by REDSPE2)

Function:

The subroutine VALUE gives a valuation to every possible combination of finishingspecification and ultimate situation and fils the array COMB(*,*) with this value.

Working:

```
BEGINSUBR

DO make all elements from the array COMB(1 til 100,1til 4) equal to 0

U = 1; U indicates the number of the ultimate situation
S = 1; S indicates the number of the finishingspecification
C = 1; C indicates the number of the combination

DO WHILE FINSPEC(S,1) NEQ empty
        BEGIN
        DO WHILE USERREQ(U,1) NEQ empty
                BEGIN
                COMB(C,1) = S
                COMB(C,2) = U
                COMB(C,4) = FINSPEC(S,18)

                DO FOR J = 1 UNTIL 4;J indicates the number of attributes in USERREQ
                        BEGIN
                        IF FINSPEC(S,J + 2) < USERREQ(U,J) THEN
                                BEGIN
                                COMB(C,3) =     COMB(C,3) + ( USERREQ(U,J) -
                                                FINSPEC(S,J + 2) ) x USERREQ(1,J,1)
                                ENDIF
                        ENDDO
```

```
DO FOR J = 5 UNTIL 17
        BEGIN
        IF FINSPEC(S,J + 2) NEQ USERREQ(U,J) THEN
                BEGIN
                IF USERREQ(U,J) EQ SS OR CO OR ZD THEN
                        BEGIN
                        IF FINSPEC(S,J) NEQ NF THEN
                                BEGIN
                                COMB(C,3) = COMB(C,3) + 5xUSERREQ(1,I,1)
                                ENDIF
                        ENDIF
                ELSE
                        BEGIN
                        COMB(C,3) = COMB(C,3) + 5xUSERREQ(1,I,J)
                        ENDELSE


                ENDIF
        ENDDO

AMOUNTULT = U
U = U + 1
C = C + 1

ENDWHILE

S = S + 1
U = 1
ENDWHILE

AMOUNTSPEC = S-1
AMOUNTCOMBI = AMOUNTULT x AMOUNTSPEC

ENDSUBR
```

Subroutine ARRANGE

Input:

COMB(*,*);
- COMB(C,*): number of the combination of finishingspecification and ultimate situation
- COMB(*,1): number of the finishingspecification
- COMB(*,2): number of the ultimate situation
- COMB(*,3): valuation of the combination
- COMB(*,4): costindication of the combination

Output:

COMB2(*,*) : (adjusted COMB(C,*))
- COMB2(*,1): number of the finishingspecification
- COMB2(*,2): number of the ultimate situation
- COMB2(*,3): valuation of the combination
- COMB2(*,4): costindication of the combination

Function:

This subroutine selects 3 interesting combinations from all the existing combinations:
- 2 combinations with a ultimate situation number equal to 1 with the highest values of all the combinations with a ultimate situation number equal to 1.
- 1 combination with a ultimate situation number not equal to 1 with the highest value of all the combination with a ultimate situation number not equal to 1.

Working:

BEGINSUBR

DO find the combination with a ultimate situation number equal to 1 with the highest values of all the combinations with a ultimate situation number equal to 1. If there appears to be more than one, then consider all of these. Call this/these ultimate situation(s) CS1. Fill the array COMB2(*,*) with this/ these CS1('s)

IF there is only 1 ultimate situation in CS1 THEN
BEGIN
DO find the combination with a ultimate situation number equal to 1 with the next highest values of all the combinations with a ultimate situation number equal to 1. If there appears to be more than one, then consider all of these. Call this/these ultimate situation(s) CS2. Fill the array COMB2(*,*) with this/ these CS2('s)
ENDIF

DO find the combination with a ultimate situation number not equal to 1 with the highest values of all the combinations with a ultimate situation number not equal to 1. If there appears to be more than one, then consider all of these. Call this/these ultimate situation(s) CS3. Fill the array COMB2(*,*) with this/ these CS3('s)

IF CS1 and CS2 do not contain more than 2 ultimatesituations THEN

```
        BEGIN
        DO fill the array COMB2(*,*) with CS3
        ENDIF
        ELSE
        IF the valuation of CS3 is higher than the valuation of CS1 THEN
                BEGIN
                DO fill COMB2(*,*) with CS3
                ENDIF
        ENDELSE

DO call the amount of ultimate situations in COMB2(*,*) : AMUS

ENDSUBR
```

Subroutine INFOCHOICE

Input:

USERREQ-array
FINSPEC-array
COMB2(*,*)

Output:

All kinds of information about the finishingspecifications

Function:

The array COMB2(*,*) contains combinations of finishingspecifications and ultimate situations. The subroutine INFOCHOICE gives information about the finishing-processes which can realise the finishingspecifications mentioned in the array COMB2(*,*). This information can be general information about the processes, absolute requirements of the processes and/or wishes of the processes.
When the user can not meet the absolute requirements of a certain process then this finishingprocess will not be considered anymore and so will the considered combination.
When the user can not meet the wishes of the process then a reductionfactor will be calculated on the valuation or the costindication which belong to the combination which is being considered.

Working:

BEGINSUBR

<u>DO FOR C = 1 UNTIL AMUS</u>

BEGIN

WRITES The finishingspecificationcode FINSPEC(COMB2(C,1),2) is very interesting for the user when the ultimate situation number COMB2(C,2) is concerned. The program will now investigate if the process with code FINSPEC(COMB2(C,1),19) can be used to realise a finish equal to the specifications of finishingspecificationnumber FINSPEC(COMB2(C,1),2).

PROCCODE = FINSPEC(COMB2(C,1),19)

DO INFOPROC

The subroutine INFOPROC gives information about the finishing-process which is mentioned in FINSPEC(COMB2(C,1),1). This information can be general information about the process, absolute requirements of the process and/or wishes of the process.
When the user can not meet the absolute requirements of the process then this finishingprocess will not be considered anymore and so will the considered combination. When the user can not meet the wishes of the process then a reductionfactor will be calculated on the valuation or the costindication which belong to the combination which is being considered.

ENDFOR

WRITES All the combinations from COMB2(*,*) with all the known datafields
Ask the user whether he wishes to determine the exact manufacturing costs for these combinations.

DO SHOWKOS for those combinations of which the user wants to determine the manufacturing costs

ENDSUBR

Subroutine INFOPROC

Input:

COMB2(*,*)
PROCCODE: The processcode of the finishingprocess of which the user will get information

Output:

COMB2(*,*) (adjusted)

Function:

The subroutine INFOPROC gives information about the finishing-process which is mentioned in *FINSPEC(COMB2(C,1),1)*. This information can be general information about the process, absolute requirements of the process and/or wishes of the process.
When the user can not meet the absolute requirements of the process then this finishingprocess will not be considered anymore and so will the considered combination. When the user can not meet the wishes of the process then a reductionfactor will be calculated on the valuation or the costindication which belong to the combination which is being considered.

Working:

```
BEGINSUBR

NOINFO = T
PROCCODE = FINSPEC(COMB2(C,1),1)

CODEPART = 1
PROCCOPART = PROCCODE( X X XX XX XXXX)
DO INFORM

DO WHILE DOOR = T
        BEGIN
        CODEPART = 2
        PROCCOPART = PROCCODE(* X XX XX XXXX)
        DO INFORM
        ENDWHILE

DO WHILE DOOR = T
        BEGIN
        CODEPART = 3
        PROCCOPART = PROCCODE(* * XX XX XXXX)
        DO INFORM
        ENDWHILE

DO WHILE DOOR = T
        BEGIN
        CODEPART = 4
        PROCCOPART = PROCCODE(X* * ** XX XXXX)
        DO INFORM
        ENDWHILE
```

```
DO WHILE DOOR = T
        BEGIN
        CODEPART = 5
        PROCCOPART = PROCCODE(* * ** **  XXXX)
        DO INFORM
        ENDWHILE

DO WHILE DOOR = T
        BEGIN
        CODEPART = 6
        PROCCOPART = PROCCODE(* * ** ** ****)
        DO INFORM
        ENDWHILE



IF NOINFO = T THEN
        BEGIN
        WRITES Errormessage.
                Unfortunately there is an error in the file PROC. Tell the man/woman who is
                responsible for this system that the processcode PROCCODE is not present in
                the file PROC but is present in the finishingspecification COMB2(C,1).
                My problem now is that I can not check whether your product meets the
                requirements of the process. Nevertheless, I will keep on considering the
                combination to which this process belongs. REMEMBER THAT YOU CAN NOT
                RELY UPON THE INFORMATION WHICH IS RELATED TO THIS PROCESS
        ENDIF
 ELSE
        BEGIN
        IF VOLEIS = T THEN
                BEGIN
                COMB2(C,3) = REDKWA1 x REDKWA2 x REDKWA3 x....x REDKWA6

         ELSE
                BEGIN
                WRITES Your design doesn't meet the absolute requirements of the
                finishingprocess     PROCCODE. For this reason I will not consider this process
                                     anymore.
                ENDELSE
        ENDELSE

ENDSUBR
```

Subroutine INFORM

Input:

CODEPART; the number of the code part
PROCCOPART; the process code which will be considered in this subroutine
PROCCODE; the process code of which PROCCOPART is a part of.

Output:

VOLEIS; is equal to TRUE when the user has indicated that his productdesign meets all the absolute requirements of the proccopart.
DOOR; is equal TRUE when the user wants to keep on getting information about the considered processcode (PROCCOPART and FINSPEC(COMB2(C,1),1))
REDKWA(1 < = CODEPART < = 25); contains the reductionfactor on quality

Function:

The subroutine INFORM gives information about the finishing-process which is mentioned in *PROCCOPART.* This information can be general information about the process, absolute requirements of the process and/or wishes of the process.
When the user can not meet the absolute requirements of the process then this finishingprocess will not be considered anymore and so will the considered combination. When the user can not meet the wishes of the process then a reductionfactor will be calculated on the valuation or the costindication which belong to the combination which is being considered.

Working:

```
BEGIN

VOLEIS = T

IF  de te beschouwen BEWCODE bestaat en als hier informatieinstaat THEN
        BEGIN
        NOINFO = F

        DO SHOWREQ

        IF DOOR = T THEN
                BEGIN
                DO SHOWGEN

                DO SHOWQUA

                ENDIF

ENDSUBR
```

Subroutine SHOWREQ

Input:

CODEPART; the number of the code part
PROCCOPART; the process code which will be considered in this subroutine
PROCCODE; the process code of which PROCCOPART is a part of.

Output:

VOLEIS; is equal to TRUE when the user has indicated that his productdesign meets all the absolute requirements of the proccopart.
DOOR; is equal TRUE when the user wants to keep on getting information about the considered processcode (PROCCOPART and FINSPEC(COMB2(C,1),1))

Function:

The subroutine SHOWREQ will check whether the productdesign meets the absolute requirements of the finishingprocess with process code PROCCODE;
If so; VOLEIS = T and DOOR = T.
If not, then VOLEIS = F and depending on the wishes of the user to continue with giving information about the process yes or no the variable DOOR = T or F.

Working:

```
BEGINSUBR

DOOR = T

READ the absolute requirement which belongs to the PROCCODE

IF this absolute requirement is present THEN
    BEGIN
    WRITES the absolute requirement which belongs to the PROCCODE
    WRITES Does your productdesign meets to these requirements ?
    READ the answer

    IF the answer is 'no' THEN
        BEGIN
        VOLEIS = F
        COMB2(C,1) = 0
        WRITES    The user cannot meet the absolute requirements of the
                  finishingprocess. He canm chose between the following options:
                  1.  In spite off not meeting the requirements he still wants
                      more information about the process PROCCODE .
                  2.  He does not want more information about the process
                      PROCCODE
        IF option 1 THEN DOOR = T
        IF option 2 THEN
            BEGIN
            DOOR = F
```

```
        WRITES   Your productdesign does not meet the absolute
                 requirements of the process PROCOPART. For that reason I
                 will not consider the process PROCODE anymore.
        ENDIF
    ENDIF


ENDSUBR
```

Subroutine SHOWGEN

Input:

CODEPART; the number of the code part
PROCCOPART; the process code which will be considered in this subroutine
PROCCODE; the process code of which PROCCOPART is a part of.

Output:

General information to the user.

Function:

The subroutine SHOWGEN shows the user general information about the finishingprocess PROCCOPART (so also about the finishingprocess PROCCODE).

Working:

```
BEGINSUBR

I = 1
POSGEN = 100

DO WHILE POSGEN NEQ 999
        BEGIN

        READ the first 20 characters of the 'general information part' I

        IF these first 20 characters of the 'general information part' I are there and not
        empty THEN
                BEGIN
                WRITES Do you want information about the following subject:
                        ' the first 20 characters of the 'general information part' I'

                IF answer = yes THEN
                        BEGIN
                        WRITES 'general information part' I
                        ENDIF
                I = I + 1
                ENDIF
         ELSE
                BEGIN
                POSGEN = 999
                ENDELSE
        ENDWHILE

ENDSUBR
```

Subroutine SHOWQUA

Input:

CODEPART; the number of the code part
PROCCOPART; the process code which will be considered in this subroutine
PROCCODE; the process code of which PROCCOPART is a part of.

Output:

General information to the user.
REDKWA(*); consists the reductionratio for the valuation.

Function:

The subroutine SHOWRES checks whether the productdesign meets to the wishes of the process PROCOPART. If it does not then either a reductionratio (REDKWA(CODEPART)) is made for the valuation of the combination or a reductionfactor (REDKOS(CODEPART)) is made for the costindication of the combination.

Working:

```
BEGINSUBR

DO FOR I = 1 UNTIL 10
      BEGIN
      IF W(I) belonging to the processcode PROCCOPART is available in file PROC THEN
            BEGIN
            WRITES The information inside W(I);
                  In order the finishingprocess to be able to make a good quality your
                  product design has to meet to this wish. Ask whether the product
                  design of the user meets to this wish. The user can chose between the
                  following options:
                  1. Yes
                  2. No
            IF option 1 THEN REDKWA(CODEPART) = 1

            IF option 2 THEN
                  BEGIN
                  READ the content of F(I) belonging to PROCOPART; call this 'FACTOR'

                  WRITES      Because your product design does not meet the wish of the
                              finishingprocess I will reduce the valuation of this
                              finishingprocess with a reductionfactor equal to:
                              'character 4,5,6 of FACTOR'.
                              The user now has the following options:
                              1. He agrees with this reductionfactor
                              2. The wish does not apply to the product design so the
                              user does not agree with this reductionfactor.
```

```
                IF option 1THEN
                    BEGIN
                    REDKWA(CODEPART) = 'character 4,5,6 of FACTOR'
                    ENDIF
                IF option 2 THEN
                    BEGIN
                    WRITES Ask the user what reductionfactor he suggests.
                    READ The suggested reductionfactor
                    REDKWA(CODEPART) =  The suggested reductionfactor
                    ENDIF
                ENDIF

            ENDIF
        ENDDO

    ENDSUBR
```

Subroutine SHOWCOS

Input:

PROCCODE; the processcode of the process which will be considered in this subroutine.

Output:

COMB2(*,4); the costindication for realising the finishingspecification on the given product with the given finishing process

Function:

This subroutine gives the possibility to the user to calculate exactly the costs of the selected finishingprocess when this is used for finishing of the product.

Working:

Mr. Helmer, manager of the cost engineering department in RXV, has just development a program which can calculate, interactively with the user, the exact costs of the selected finishingprocess when this is used for finishing of the product.
It is no use to show the workoing of the program here. When management decides to go on with this project then the specifications for this subroutine can be received from Mr. Helmer.

Subroutine PRESENT

Input:

USERREQ-arrays
FINSPEC-arrays
COMB2(*,*)

Output:

Information to the user about the valuations and costindications of the different combinations of finishingspecifications and ultimate situations.

Function:

The array COMB2(*,*) contains for every combination of finishingspecification and ultimate situation the valuation and the cost indication. The subroutine PRESENT presents these combinations to the user in a userfriendly way.

Working:

BEGINSUBR

DO present on screen 1:

1. The combination with the best valuation
2. The combination with the second best valuation
3. The combination with the third best valuation

DO present on screen 2

All the combinations with decreasing valuation

Give the user the possibility to switch between screen 1 and 2 or to go on with the subroutine KINFO.

ENDSUBR

Subroutine SPECINFO

Input:

User-questions about the finishingspecifications.

Output:

Information about the finishingspecification(s)

Function:

The function of this subroutine is to give information about the finishingspecifications. The user can ask for information about one single finishingspecification but also about certain finishingspecifications which meet to the constraints made by the user himself.
The information about a finishingspecification contains all the values which this finishingspecification has for all the possible attributes of a finishingspecification plus some remarks (if present).

Working:

BEGINSUBR

POSSPE = 100

DO WHILE POSSPE NEQ 999

BEGIN
The user can choose one of the following options:
1. Getting information about one single finishingspecification
2. Getting information about certain finishingspecifications which meet to the constraints which can be made by the user himself.
3. Go back to the main menu.

IF option 1 THEN DO
BEGIN
The user can tell about what finishingspecification he wants information and which charsteristics interest him.
Then the required information is being looked up in the file SPEC and will be shown to the user.
END

IF option 2 THEN DO
BEGIN
First the user has the possibility to define the constraints he wants to make.
Then in those finishingspecifications in the file SPEC which meet to these constraints wil be selected.
These selected finishingspecifications will be shown to the user.
END

IF option 3 THEN DO POSSPE = 999

Subroutine PROCINFO

Input:

Questions of the user for information about (a) finishingprocess(es)

Output:

Information about a given finishingprocess

Function:

The function of subroutine PROCINFO is to give information about a choosen finishingprocess or about a certain collection of finishingprocesses. This information can contain general information about the process(es), absolute requirements of the process(es) and wishes of the process(es). The user is also being told what happens if he doesn't meet to these wishes.

Working:

BEGINSUBR

The user can tell the system about what finishingprocess(es) he wants information.
Then PROCINFO will search for this information in the file PROC and show it to the user.

ENDSUBR

Subroutine UPDATE

This subroutine gives the possibility to update the files SPEC and PROC.

The user can:
- make new PROC-codes;
- make new finishingspecifications
- update excisting PROC-codes
- update excisting finishingspecifications

DESCRIPTION OF THE DATA

AMOUNTSPEC: Contains the amount of selected finishingspecifications (by REDSPE2)

AMOUNTTEN: Contains theamount of attributes of which the values are absolutely required by the user.

AMOUNTULT: Contains the amount of ultimate situations in the array COMB

ASPEC(I,J): Contains the finishingspecification-numbers which have I times theier value equal to a value which is absolutely required .

CODEPART: Contains the number of the Finishingprocess-sub-code (PROCCOPART) given by the subroutine INFOPROC.

COMB(C,I): Contains for a combination of ultimate situation and finishingspecification the combination number, the finishingspecificationnumber, the valuation of the combination, the costs of the combination;

- COMB(C,*): number of the combination of finishingspecification and ultimate situation
- COMB(*,1): number of the finishingspecification
- COMB(*,2): number of the ultimate situation
- COMB(*,3): valuation of the combination
- COMB(*,4): costindication of the combination

COMB2(C,I): Contains for a combination of ultimate situation and finishingspecification the combination number, the finishingspecificationnumber, the valuation of the combination, the costs of the combination;

- COMB2(C,*): number of the combination of finishingspecification and ultimate situation
- COMB2(*,1): number of the finishingspecification
- COMB2(*,2): number of the ultimate situation
- COMB2(*,3): valuation of the combination
- COMB2(*,4): costindication of the combination

DOOR; is equal TRUE when the user wants to keep on getting information about the considered processcode (PROCCOPART and FINSPEC(COMB2(C,1),1))

FINSPEC(S,I): This array contains the interesting finishingspecifications and their values for the different attributes of a finishingspecification.

S indicates the number of the finishingspecification given by INFOFINISH
I indicates the number of the attribute:

1. Number of the finishingspecification in SPEC = finishingspecification number
2. Finishingspecificationcode
3. Thickness increase
4. Hardness
5. Abrasion
6. Corrosion
7. Raw material
8. Color/description
9. Color & Appearance-nummer
10. Reflectivity and importance
11. Dielectric Strength
12. Insulation resistance

13.Paper friction
14.Greasing property
15.High temperature
16.Flexibility
17.Elongation
18.Cost indication
19. Finishingprocess code
20. Remarks

PROCCOPART: Contains the nuber of the finishingprocess code part which is developed out of PROCCOPART.

PROCCODE: This is the finishingprocess code which is being considered by INFOPROC.

REDKWA; Contains the reductionfactor on quality

USERREQ(U,I,J): This array contains the requirements of the user for the required values for the attributes of the ultimate finish.
U indicates the number of the ultimate situation required by the user
I indicates the number of the attribute:
1. Thickness increase
2. Hardness
3. Abrasion
4. Corrosion
5. Raw material
6. Color/description
7. Color & Appearance-nummer
8. Reflectivity and importance
9. Dielectric Strength
10.Insulation resistance
11.Paper friction
12.Greasing property
13.High temperature
14.Flexibility
15.Elongation
J = 1 indicates for the rquired value
J = 2 indicates the importancy of the required value

VOLEIS; is equal to TRUE when the user has indicated that his productdesign meets all the absolute requirements of the proccopart.

Appendix 8:

Description of the attributes of a finishingspecification

In this appendix every attribute of a finishingspecification is described by giving the definitions of the attribute and a description of the attribute. When hard figures for certain attributes are mentiioned then these have reference to the test specifications mentioned document numbers 50-2000 and 50-2065 of MN6.
For the most part, the definitions of this data can be read without any explanation once the mathematical operators, or notations are understood. These are defined as follows:

x = a + b x consists of data elements a and b
x = [a | b] x consists of either a or b
x = (a) x consists of an optional data element a
x = {a} x consists of zero or more occurences of a
x = y{ a} x consists of y or more occurences of a
x = a{ z} x consists of z or fewer occurences of a
x = y{ a}z x consists of between y and z occurences of a

For example the object COWS = 2 COW consists of one or more occurences of the object COW.

1. Number of the finishingspecification = 5{ digit} 5

This is the key of the datafile SPEC.

2. Finishingspecification code = 4 {digit} 4

Under the code 50-"finishingspecification code" the finishingspecifications are described in MN6.

3. Thickness increase = [0 | 1 | 2 | 3 | 4 | 5]

The value 0 stands for "not applicable or thicknessincrease = 0"
The value 1 stands for "0 um < thickness increase of the surface < = 10 um"
The value 2 stands for "10 um < thickness increase of the surface < = 20 um"
The value 3 stands for "20 um < thickness increase of the surface < = 30 um"
The value 4 stands for "30 um < thickness increase of the surface < = 40 um"
The value 5 stands for "4o um < thickness increase of the surface "

The thickness increase specifies the increase of the surface after being processed. The value "4" is necessary for all surfaces on the outside of a machine.

4. Hardness = [0 | 1 | 2 | 3 | 4 | 5]

The value 0 stands for "not applicable or hardness = 0"

The value 1 stands for "surface hardness equal to H.B. or H"
This hardness can be applied for protection only.

The value 2 stands for "surface hardness equal to 2H, 3H or 4H". This hardness must be applied for decorative finishes.

The value 3 stands for "surface hardness greater than 4H"

The value 4 stands for "a very hard surface hardness". This can be applied for e.g. parts in the paperpath. Mostly Nikkel is used to realise this surface-hardness.

The value 5 stands for "very special surface hardnesses". This can be applied when a very special hard surface is required. Mostly Chromium is used to realise this surface-hardness.

5. Abrasionresistance = [0 | 1 | 2 | 3 | 4 | 5]

The value 0 stands for "not applicable or abrasionresistance = 0"

The value 1 stands for "no special requirements for the abrasionresistance"
This can be applied for protection only.

The value 2 stands for "less than 150 grams loss in the abrasionresistance test"
This abrasionresistance hardness can be applied for decorative finishes or normal paintrequirements.

The value 3 stands for "less than 50 grams loss in the abrasionresistance test"
This can be applied for parts in the paperpath and can be realised by e.g. Zinc.

The value 4 stands for "less than 25 grams loss in the abrasionresistance test".
For very high abrasionresistance.

The value 5 stands for "very special abrasionresistancerequirements".
Mostly Nickel is used to realise this surface-hardness. Sometimes chromium. Chromium is less applied but a higher abrasionresistance.

6. Corrosion resistance = [0 | 1 | 2 | 3 | 4 | 5]

The value o stands for "not applicable or corrosionresistance = 0"

The value 1 stands for "the finished article shall show no signs of corrosion after subjection to 10 cycles (240 h or 10 d) of humidity test per 50-2065"
For normal inhouse situations .

The value 2 stands for "the finished articles shall show no signs of corrosion after subjection to the 300 h humidity test per 50-2000.
For tropicle inhouse situations.

The value 3 stands for "the finished article shall show no sign of corrosion after subjection to 14 cycles 24 hours humidity test per 50-2065"
For inhouse situations with great changements in temperatures.

The value 4 stands for "the finished article shall show no sign of corrosion after subjection to 48 hours saltspraytest per 50-2065 For heavy inhouse situations.

The value 5 stands for "the finished article shall show no sign of corrosion after subjection to a saltspray test (per 50-2065) of 180 until 280 hours.
For agressive situations outside the house. This requirement also goes for paintings on cars.

7. Raw material = [XX | ST | AL | SS | CO | PW | FP | PL | ZD | FA | NF]

XX stands for no specification
ST stands for steel
AL stands for aluminium
SS stands for stainless steel

CO stands for copper
PW stands for printed wiring board
PL stands for plastic
ZD stands for zinc die castings
NF stands for non ferrous metals
This is the same distinguishing of raw material as in MN3 and in lit.$\frac{1}{4}$??$\frac{3}{4}$

8. Color = 0 {character} 25

This attribute describes the color of a surface. It can be build out of all kinds of words: black, blue, yellow, red, orange brown, green, white, textured, low gloss, high gloss, smooth, dark, light, yellowish etc.

9. Color and appearance number = 4{ digit} 4

A color and appearance (C/A-number) number specifies the requirements for the color and appearance of the surface. The specifications which belong to a C/A-number are decribed in MN6.

10. Reflectivity = [A I X I R I N]

This attribute specifies the kind of reflectivity of the surface.
The value A stands for a light absorbing surface.
The value X stands a "Xerox light reflecting" surface.
The value R stands for a light reflecting surface.
The value N stands for not applicable.

This attribute can be applied for certain parts in the optic of a copier.

11. Dielectric strength = []Y I N]

This attribute specifies whether a surface can stop an electrical shock (1000 Volt, AC or DC) during 30 to 60 seconds time yes or no.

12. Insulation resistance = [Y I N]

This attribute specifies whether a surface needs to have a certain electrical resistance.

13. Friction = [H I L I N]

The value H stands for a high friction.
The value L stands for a surface with an extreme low friction.
The value N stands for not applicable.

14. Greasing property = [Y I N]

The value Y stands for a surface with good greasing properties.

15. High temperature resistance = [Y I N]

The value Y stands for a surface with a high temperature resistance (300 degrees Celcius).

16. Flexibility = Y[I N]

- The value Y stands for a surface with a high flexibility (no cracking, buckling or holes after subjection to 10 000 cycles, flat to 1m bending radius, 08-0027 substrate).

17. Elongation = [Y I N]

The value Y stands for "elongation possible to 10 % minimum.

18. Costs = 4{ digit} 4

The value stands for a costindication for realising the finishingspecification relative to the other ones. See the table for the costindication of anorganic finishes:

Finishing specification number	Finishing Costs per dm2 in DFL	Cost indication
50-0002	0.13	100
50-0006	0.156	120
50-0007	0.13	100
50-0009	1.04	800
50-0010	0.325	250
50-0012	0.169	130
50-0015	0.26	200
50-0016	0.585	430

For the organic finishspecifications (these have their finishingspecificationnumber higher than 0500) the costindication always amounts to" 84". (= 11 cents (fl 0.11) per dm2. This figure goes for the following circumstances:
2 robots paint the front side, one robot paints the backside; every robot paints with 20 % loss; every robot paints 70 dm2/min; no more than 4 parts on one rack; conveyer speed = 2 m/sec; distances of hanging pins = 30 cm;

19. Finishingprocess code = 10{ characte}r 10

This code specifies the code of the finishingprocess which can realise the considered finishingspecification.

20. Remarks = 0{ character} 25

Room fore some remarks related with the considered finishingspecification.

The following attributes do not exist in the datafile SPEC but all the finishingspoecifications meet these requirements. They may be shown to the user as extra information:

Adhesion
All the finishingspecifications meet the adhesiontest mentioned in spec 50-2000.

Cleanability and tonercompatibility
All finishingspecifications have to resist the curent cleaners or toners.(see spec 50-2000)

Heat resistance
All finishingspecifications can stand the standard temperature resistance test.

Exposure stability
No adverse effects after beig exposed to daylight.
No surface may show adverse effects after being subject to ASTM G25 120 hours, black panel 52 + - 3 degr. Celsius.

Chemical resistance
All surfaces have to withstand certain chemical stuff (see spec 50-2000)

Appendix 9:

Converted information for the file SPEC

ICONVERTED INFORMATION FOR THE FILE SPEC

In this appendix I describe every occurence of the object "Finishing specification" by giving its values for the attributes.

FINISHINGSPECIFICATIES OF ANORGANISCHE FINISHES

Code	: 50-0001
Number	:00001
Ingangsmateriaal	:ST
Thichnessincr.	:2
Color	: black::
Colorand appearance	:
Hardness	:0
Abrasionresistance	:1
Corrosionresistance	:3
Reflectivity	: n
Dielectricstrength	:l
Insulationresistance	:l
Friction	: n
Greasingproperty	: y
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	: ?
Process code	:C X ST FZ 0001
Remark	:

Code	:50-0004Number : 00002
Ingangsmateriaal	:FP
Thichnessincrease	:1
Color	:
Visual character1	:
Visual character2	:
Colorand appearance	:0
Hardness	:0
Abrasionresistance	:0
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	:?
Process code	:A M FP OI

Code	:50-0003
Number	: 00003
Ingangsmateriaal	:FP
Thicknessincrease	:1
Color	:
Colorand appearance	:
Hardness	:0
Abrasionresistance	:0
Corrosionresistance	:3
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	:?
Process code	:X X XX XX 0003
Remark	:

Code	:50-0004
Number	:Rust preventive dry film
Ingangsmateriaal	:ST
Thicknessincrease	:0
Color	:
Colorand appearance	:
Hardness	:0
Abrasionresistance	:0
Corrosionresistance	: 2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	:?
Process code	:A M ST OI
Remark	:

Code	: 50-0006

CONVERTED INFORMATION FOR THE FILE SPEC

In this appendix I describe every occurence of the object "Finishing specification" by giving its values for the attributes.

FINISHINGSPECIFICATIES OF ANORGANISCHE FINISHES

Code	: 50-0001
Number	:00001
Ingangsmateriaal	:ST
Thichnessincr.	:2
Color	: black::
Colorand appearance	:
Hardness	:0
Abrasionresistance	:1
Corrosionresistance	:3
Reflectivity	: n
Dielectricstrength	:l
Insulationresistance	:l
Friction	: n
Greasingproperty	. y
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	: ?
Process code	:C X ST FZ 0001
Remark	:

Code	:50-0004Number : 00002
Ingangsmateriaal	:FP
Thichnessincrease	:1
Color	:
Visual character1	:
Visual character2	:
Colorand appearance	:0
Hardness	:0
Abrasionresistance	:0
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	:?
Process code	:A M FP OI

Code	:50-0003
Number	: 00003
Ingangsmateriaal	:FP
Thicknessincrease	:1
Color	:
Colorand appearance	:
Hardness	:0
Abrasionresistance	:0
Corrosionresistance	:3
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	:?
Process code	:X X XX XX 0003
Remark	:

Code	:50-0004
Number	:Rust preventive dry film
Ingangsmateriaal	:ST
Thicknessincrease	:0
Color	:
Colorand appearance	:
Hardness	:0
Abrasionresistance	:0
Corrosionresistance	: 2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Elongation	: n
Costindication	:?
Process code	:A M ST OI
Remark	:

Code	: 50-0006

Number :Zinc Electroplate/Black Chromate Finish
Ingangsmateriaal :ST
Thicknessincrease :1
Color : black:
Colorand appearance :
Hardness :3
Abrasionresistance :3
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance : n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Elongation : n
Costindication : 120
Process code :AESTZI-CXZICR
Remark :

Code :50-0007
Number :00007
Ingangsmateriaal :ST
Thicknessincrease :1
Color : yellow:
Colorand appearance :
Hardness :3
Abrasionresistance :3
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Elongation : n
Costindication : 100
Process code :AESTZI
Remark :

Code :50-0012
Number :00012
Ingangsmateriaal :al
Thicknessincrease :1
Color : black:
Colorand appearance : 99-0080
Hardness :4
Abrasionresistance :4
Corrosionresistance :4
Reflectivity :n
Dielectricstrength :y
Insulationresistance :y
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Elongation : n
Costindication :130
Process code :CEALOX

Remark :

Code : 50-0011
Number :00011
Ingangsmateriaal :al
Thicknessincrease :1
Color :: gray metallic lustrous (undyed)
Colorand appearance :
Hardness :4
Abrasionresistance :4
Corrosionresistance :4
Reflectivity :n
Dielectricstrength :y
Insulationresistance :y
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Elongation : n
Costindication :?
Process code :CEALOX

Remark : Een zwavelzuur anodiseerlaag ?

Code : 50-0013
Number :00013
Ingangsmateriaal :al
Thicknessincrease :5
Color ::dark gray, uniform and smooth
Colorand appearance :
Hardness :5
Abrasionresistance :5
Corrosionresistance :5
Reflectivity :n
Dielectricstrength :y
Insulationresistance :y
Friction : n
Greasingproperty : n
Costindication :?

Process code :CEALOX
Remark :

Code : 50-0015
Number :10015
Ingangsmateriaal :ST
Thicknessincrease :1
Color :: NIKKEL
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :?
Process code :AESTNI
Remark . Komt vaker voor dan 50-0016,ST

Code : 50-0015
Number :20015
Ingangsmateriaal .AL
Thicknessincrease :1
Color :: NIKKEL
Colorad appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :200
Process code :AEALNI
Remark :

Code : 50-0015
Number :30015
Ingangsmateriaal :CO
Thicknessincrease :1
Color :: NIKKEL
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :200
Process code :AECONI
Remark :

Code : 50-0015
Number :40015
Ingangsmateriaal :SS
Thicknessincrease :1
Color :: NIKKEL
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :200
Process code :AESSNI
Remark :

Code . 50-0015
Number :50015
Ingangsmateriaal :ZI
Thicknessincrease :1
Color :: NIKKEL
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :200
Process code :AEZINI
Remark :

Code : 50-0016
Number :10016
Ingangsmateriaal :ST
Thicknessincrease :1
Color ::METALIC BRIGHT, SMOOTH AND UNIFORM
Colorand appearance :

Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :450
Process code :ACSTNI
Remark :

Code : 50-0016
Number :20016
Ingangsmateriaal :AL
Thicknessincrease :1
Color :::
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :450
Process code :ACALNI
Remark :

Code : 50-0016
Number :30016
Ingangsmateriaal :CO
Thicknessincrease :1
Color :::
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :450
Process code :ACCONI
Remark :

Code : 50-0016
Number :ELECTROLESS NIKKEL COATING
Ingangsmateriaal :RV
Thicknessincrease :1
Color :::METALIC BRIGHT AND UNIFORM
Colorand appearance :
Hardness :4
Abrasionresistance :5
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication : 450
Process code :ACRVNI
Remark :

Code : 50-0009
Number : 10009
Ingangsmateriaal :ST
Thicknessincrease :5
Color :::WHITE OR BRIGHT AND SMOOTH
Colorand appearance :
Hardness :5
Abrasionresistance :5
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication :800
Process code :AESTCR
Remark : De dikte is envoudig te varieren.

Code : 50-0009
Number :ELECTROPLATED HARD CHROMIUM COATING
Ingangsmateriaal :RV
Thicknessincrease :5
Color :::WHITE OR BRIGHT AND SMOOTH
Colorand appearance :
Hardness :5
Abrasionresistance :5
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n

Friction : L
Greasingproperty : n
Costindication :800
Process code :AERVCR
Remark :

Code : 50-0010
Number : 100010
Ingangsmateriaal : ST
Thicknessincrease : 5
Color : Bright, high gloss::
Colorand appearance .99-0126 Hardness : 5
Abrasionresistance : 5
Corrosionresistance : 3
Reflectivity : n
Dielectricstrength : n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication : ?
Process code : AESTCR
Remark :

Code . 50-0010
Number 200010
Ingangsmateriaal : SS
Thicknessincrease : 5
Color : Bright, high gloss::
Colorand appearance :99-0126 Hardness : 5
Abrasionresistance : 5

Corrosionresistance : 3
Reflectivity : n
Dielectricstrength : n
Insulationresistance :n
Friction : L
Greasingproperty : n
Costindication : ?
Process code : AESSCR
:

FINISHING SPECIFICATIES VAN ORGANISCHE FINISHES

Code : 50-0506
Number :
Ingangsmateriaal :ST
Thicknessincrease :2
Color : black::matte
Colorand appearance : 99-0080
Hardness :1
Abrasionresistance :1
Corrosionresistance :2
Reflectivity :a
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0506
Number :
Ingangsmateriaal :NF
Thicknessincrease :2

Color : black::matte
Colorand appearance : 99-0080
Hardness :1
Abrasionresistance :1
Corrosionresistance :2
Reflectivity :a
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0506
Number :
Ingangsmateriaal :PL
Thicknessincrease :1
Color : black::smooth
Colorand appearance : 99-0080
Hardness :1
Abrasionresistance :1
Corrosionresistance :2
Reflectivity :a
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code :50-0601

Number :
Ingangsmateriaal :ST
Thicknessincrease :3
Color : pinkish grey low gloss::
Colorand appearance : 99-0315
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0601
Number :
Ingangsmateriaal :NF
Thicknessincrease :3
Color : pinkish gray low gloss::
Colorand appearance : 99-0314
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0601
Number :
Ingangsmateriaal :PL
Thicknessincrease :1
Color : Pinkish grey low gloss::
Colorand appearance : 99-0314
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code :50-0602
Number :10602
Ingangsmateriaal :ST
Thicknessincrease :3
Color : pinkish grey low gloss::
Colorand appearance : 99-0315
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0602
Number :20602
Ingangsmateriaal :NF
Thicknessincrease :3
Color : pinkish gray low gloss::
Colorand appearance : 99-0314
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0602
Number :30602
Ingangsmateriaal :PL
Thicknessincrease :1
Color : Pinkish grey low gloss::
Colorand appearance . 99-0314
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n

Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Costindiction	: 84
Process code	.O X PL XX
Remark	:

Code	:50-0603
Number	:10603
Ingangsmateriaal	:ST
Thicknessincrease	:3
Color	: pinkish grey low gloss::
Colorand appearance	: 99-0315
Hardness	:2
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	.n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	. n
Costindiction	: 84
Process code	O X ST XX
Remark	:

Code	: 50-0603
Number	:20603
Ingangsmateriaal	:NF
Thicknessincrease	:3
Color	: pinkish gray low gloss::
Colorand appearance	: 99-0314
Hardness	:2
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Costindiction	: 84
Process code	:O X NF XX
Remark	:

Code	: 50-0603
Number	:30603
Ingangsmateriaal	:PL
Thicknessincrease	:1
Color	: Pinkish grey low gloss::
Colorand appearance	: 99-0314
Hardness	:1
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Costindiction	: 84
Process code	:O X PL XX
Remark	:

Code	:50-0604
Number	:10604
Ingangsmateriaal	:ST
Thicknessincrease	:3
Color	: pinkish grey low gloss::
Colorand appearance	: 99-0315
Hardness	:2
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Costindiction	: 84
Process code	:O X ST XX
Remark	:

Code	: 50-0604
Number	:20604
Ingangsmateriaal	:NF
Thicknessincrease	.3
Color	: pinkish gray low gloss::
Colorand appearance	: 99-0314
Hardness	:2
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Costindiction	: 84
Process code	:O X NF XX
Remark	:

Code : 50-0604
Number : 30604
Ingangsmateriaal : PL
Thicknessincrease : 1
Color : Pinkish grey low gloss::
Colorand appearance : 99-0314
Hardness : 1
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code : O X PL XX
Remark :

Code : 50-0605
Number : 10605
Ingangsmateriaal : ST
Thicknessincrease : 3
Color : pinkish grey low gloss::
Colorand appearance : 99-0315
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code : O X ST XX
Remark :

Code : 50-0605
Number : 20605
Ingangsmateriaal : NF
Thicknessincrease : 3
Color : pinkish gray low gloss::
Colorand appearance : 99-0314
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code : O X NF XX
Remark :

Code : 50-0605
Number : 30605
Ingangsmateriaal : PL
Thicknessincrease : 1
Color : Pinkish grey low gloss::
Colorand appearance : 99-0314
Hardness : 1
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code : O X PL XX
Remark :

Code : 50-0606
Number : 10606
Ingangsmateriaal : ST
Thicknessincrease : 3
Color : pinkish grey low gloss::
Colorand appearance : 99-0315
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code : O X ST XX
Remark :

Code : 50-0606
Number : 20606
Ingangsmateriaal : NF
Thicknessincrease : 3
Color : pinkish gray low gloss::

Colorand appearance . 99-0314
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0606
Number :30606
Ingangsmateriaal :PL
Thicknessincrease .1
Color : Pinkish grey low gloss::
Colorand appearance : 99-0314
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction . n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code :50-0608
Number :10608
Ingangsmateriaal :ST
Thicknessincrease :3
Color : light purpish blue low gloss::
Colorand appearance : 99-0315
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0608
Number :20608
Ingangsmateriaal :NF
Thicknessincrease :3
Color : pinkish gray low gloss::
Colorand appearance : 99-0314
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0608
Number :30608
Ingangsmateriaal :PL
Thicknessincrease :1
Color : Pinkish grey low gloss::
Colorand appearance : 99-0314
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code :50-0609

Number : 10609
Ingangsmateriaal : ST
Thicknessincrease : 3
Color : moderate purplish blue low gloss::
Colorand appearance : 99-0315
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code : O X ST XX
Remark :

Code : 50-0609
Number : 20609
Ingangsmateriaal : NF
Thicknessincrease : 3
Color : pinkish gray low gloss::
Colorand appearance : 99-0314
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code : O X NF XX
Remark :

Code : 50-0609
Number : 30609
Ingangsmateriaal : PL
Thicknessincrease : 1
Color : Pinkish grey low gloss::
Colorand appearance : 99-0314
Hardness : 1
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code : O X PL XX
Remark :

Code : 50-0701,2,3,4,6,8
Number :
Ingangsmateriaal : ST
Thicknessincrease : 4
Color : pinkish gray textured::
Colorand appearance : 99-0326
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code : O X ST XX
Remark :

Code : 50-0701,2,3,4,6,8
Number :
Ingangsmateriaal : NF
Thicknessincrease : 4
Color : pinkish gray textured::
Colorand appearance : 99-0326
Hardness : 2
Abrasionresistance : 2
Corrosionresistance : 2
Reflectivity : n
Dielectricstrength : n
Insulationresistance : n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code : O X NF XX
Remark :

Code : 50-0701,2,3,4,6,8
Number :

Ingangsmateriaal :PL
Thicknessincrease :1
Color : pinkish gray textured::
Colorand appearance : 99-0326
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark .

Code :50-0544,48
Number :
Ingangsmateriaal :ST
Thicknessincrease :3
Color : medium grey low gloss::
Colorand appearance : 99-0256
Hardness :2
Abrasionresistance :2
Corrosionresistance :2

Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0544,48
Number :
Ingangsmateriaal :NF
Thicknessincrease :3
Color : medium gray low gloss::
Colorand appearance : 99-0256
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0544,48
Number :

Ingangsmateriaal :PL
Thicknessincrease :1
Color : medium gray low gloss::
Colorand appearance : 99-0256
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code :50-0553, 0555
Number :
Ingangsmateriaal :ST
Thicknessincrease :4
Color : medium gray textured::
Colorand appearance : 99-0257
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n

Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0553,0555
Number :
Ingangsmateriaal :NF
Thicknessincrease :4
Color : medium gray textured::
Colorand appearance : 99-0257
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0553,0555
Number :
Ingangsmateriaal :PL
Thicknessincrease :1
Color : medium gray textured::
Colorand appearance : 99-0257
Hardness :1

Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code :50-0528
Number :
Ingangsmateriaal :ST
Thicknessincrease :3
Color : vivid green low gloss::
Colorand appearance : 99-0224
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code : 50-0528
Number :
Ingangsmateriaal :NF
Thicknessincrease :3
Color : vivid green low gloss::
Colorand appearance : 99-0224
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0528
Number :
Ingangsmateriaal :PL
Thicknessincrease :1
Color :vivid green low gloss::
Colorand appearance : 99-0224
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n

Hightemperature res : n
Flexible : n
Costindiction : 84
Process code .O X PL XX
Remark :

Code :50-0522
Number :
Ingangsmateriaal :ST
Thicknessincrease :5
Color : white::
Colorand appearance : 99-0229
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :y
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark :

Code . 50-0522
Number :
Ingangsmateriaal :NF
Thicknessincrease :5
Color : white:.
Colorand appearance : 99-0229
Hardness :2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :y
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X NF XX
Remark :

Code : 50-0522
Number : 10522
Ingangsmateriaal :PL
Thicknessincrease :1
Color : white::
Colorand appearance : 99-0229
Hardness :1
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :y
Dielectricstrength :n
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code : 50-0523
Number : 10523
Ingangsmateriaal :ST
Thicknessincrease : 2
Color : dark grayisch olive::
Colorand appearance : 99-0229
Hardness : 2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :y
Insulationresistance :n
Friction : n
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark .

Code : 50-0523
Number :20523
Ingangsmateriaal :NF
Thicknessincrease : 2
Color : dark grayisch olive::
Colorand appearance : 99-0229
Hardness : 2
Abrasionresistance :2
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :y

Insulationresistance :n

Friction : n

Hightemperature res : n

Flexible : n

Greasingproperty : n

Costindiction : 84

Process code :O X NF XX

Remark :

Code : 50-0523

Number :30523

Ingangsmateriaal :PL

Thicknessincrease : 1

Color : dark grayisch olive::

Colorand appearance : 99-0229

Hardness : 1

Abrasionresistance :2

Corrosionresistance :2

Reflectivity :n

Dielectricstrength :y

Insulationresistance :n

Friction : n

Greasingproperty : n

Hightemperature res : n

Flexible : n

Costindiction · 84

Process code :O X PL XX

Remark :

*

Code : 50-0524

Number :10524

Ingangsmateriaal :ST, PL NF

Thicknessincrease : 5

Color : black::

Colorand appearance :

Hardness :?

Abrasionresistance :?

Corrosionresistance :?

Reflectivity :?

Dielectricstrength :?

Insulationresistance? :

Lowpaperfriction :?

Greasingproperty :?

Hightemperature res :?

Flexible : Wel tensile strength en elongation

Costindiction : 84

Process code :O X XX XX

Remark :

*

Code : 50-0532

Number :10532

Ingangsmateriaal :ST,PL,NF

Thicknessincrease : 45

Color : white::

Colorand appearance : 99-0159

Hardness : ?

Abrasionresistance :?

Corrosionresistance :?

Reflectivity :?

Dielectricstrength :?

Insulationresistance :?

Friction : ?

Greasingproperty : ?

Hightemperature res : ?

Flexible : Y

Costindiction : 84

Process code :O X XX XX

Remark :

*

Code : 50-0536

Number :10536

Ingangsmateriaal :ST, NF, PL

Thicknessincrease : 3

Color : white::

Colorand appearance :

Hardness : 1

Abrasionresistance : 1

Corrosionresistance : 1

Reflectivity :y

Dielectricstrength :n

Insulationresistance :n

Friction : H

Greasingproperty . n

Hightemperature res : n

Flexible : n

Costindiction : 84

Process code :O X PL XX

Remark :

Code : 50-0539

Number :10539

Ingangsmateriaal :ST,PL.NF

Thicknessincrease : 3

Color : grey:: matte

Colorand appearance :

Hardness : 1

Abrasionresistance :?

Corrosionresistance :?

Reflectivity :?

Dielectricstrength	:?
Insulationresistance	:?
Friction	: ?
Greasingproperty	: ?
Hightemperature res	: y
Flexible	: ?
Costindiction	: 84
Process code	:O X XX XX
Remark	:

Code	:50-0527
Number	:10527
Ingangsmateriaal	:ST
Thicknessincrease	:5
Color	: white::
Colorand appearance	: 1
Hardness	:
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:x
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	. n
Flexible	: n
Costindiction	: 84
Process code	:O X ST XX
Remark	:

Code	: 50-0527
Number	: 20527
Ingangsmateriaal	:NF
Thicknessincrease	:5
Color	: white::
Colorand appearance	: 99-0229
Hardness	:1
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:x
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Costindiction	: 84
Process code	:O X NF XX
Remark	:

Code	: 50-0527
Number	: 30527
Ingangsmateriaal	:PL
Thicknessincrease	:5
Color	: black::
Colorand appearance	: 99-0229
Hardness	:1
Abrasionresistance	:2
Corrosionresistance	:2
Reflectivity	:x
Dielectricstrength	:n
Insulationresistance	:n
Friction	: n
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Costindiction	: 84
Process code	:O X PL XX
Remark	:

Code	: 50-0570
Number	: 10570
Ingangsmateriaal	:ST
Thicknessincrease	:3
Color	: black matte smooth::
Colorand appearance	:
Hardness	:2
Abrasionresistance	:3
Corrosionresistance	:2
Reflectivity	:n
Dielectricstrength	:n
Insulationresistance	:n
Friction	: L
Greasingproperty	: n
Hightemperature res	: n
Flexible	: n
Costindiction	: 84
Process code	:O X ST XX
Remark	:

Code	: 50-0570
Number	: 20570
Ingangsmateriaal	:NF
Thicknessincrease	:3
Color	: black matte smooth::
Colorand appearance	:
Hardness	:2
Abrasionresistance	:3

Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction . 84
Process code .O X NF XX
Remark .

Code : 50-0570
Number : 30570
Ingangsmateriaal : PL
Thicknessincrease :3
Color : black matte smooth::
Colorand appearance :
Hardness :2
Abrasionresistance :3
Corrosionresistance :2
Reflectivity :n
Dielectricstrength :n
Insulationresistance .n
Friction : L
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX
Remark :

Code : 50-0560
Number : 10560
black
Ingangsmateriaal : ST
Thicknessincrease :2
Color : black smooth::
Colorand appearance :
Hardness :2
Abrasionresistance :4
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X ST XX
Remark :
electrostatisch)
(ook zo 0570

Code : 50-0560
Number : 20560
black
Ingangsmateriaal : NF
Thicknessincrease :2
Color : black smooth::
Colorand appearance :
Hardness :2
Abrasionresistance :4
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X NF XX
Remark :
electrostatisch)
(ook zo 0570

Code : 50-0560
Number : 30560
black
Ingangsmateriaal : PL
Thicknessincrease :2
Color : black smooth::
Colorand appearance :
Hardness :2
Abrasionresistance :4
Corrosionresistance :3
Reflectivity :n
Dielectricstrength :n
Insulationresistance :n
Friction : L
Greasingproperty : n
Hightemperature res : n
Flexible : n
Costindiction : 84
Process code :O X PL XX

APPENDIX 10: INFORMATION CONVERTED FOR FILE PROC

In this appendix the information which is converted for the file PROC is shown. The information is indicated by giving the code of "a collection of finishingspecifications" and an attribute.
The object "finishing processes" has 5 attributes which are:

1. One finishing process code. This is the key of the datafile PROC.
2. General information about the finishing process. This kind of information is indicated with an "A".
3. Absolute requirements of the finishing process for the commencing attributes of the product to be processed. If the user does not meet these requirements than the finishing process can not be applied for realising the users' wishes for the product surface. This kind of information is indicated with an E.
4. One or more wishes of the finishing processes for the commencing attributes of the product. If the user can not fulfil these wishes than this will mean that the finishing process can not fully realise the required characteristics.This kind of information is indicated with an W(number of the requirement)
   When the user can not meet the finishing processes' wish then INFOFINISH takes a reduction-ratio into account which is also part of this attribute. This kind of information is indicated with an F(number of the requirement)
5. Reference to the place where the costcalculationprogram can be found. This can be used if the user wants to calculate the exact costs of realising his wishes with one of the finishing processes out of the considered collection. This is not yet filled in. See the remark in subroutine SHOWCOS

The information is order to the finishing process code.

In the description of the General Information, the underlined words are the first 25 characters (or less than that) of a datafield. As can be read in the subroutine SHOWGEN these characters will first be shown to the user. Then the user can decide whether he wants to see information related with these characters or not.

The given information is not complete. This appendix is mainly ment to show the possibilities in PROC . Secondly this can also be used when all the needed information will have to be converted.

1. GENERAL INFORMATION

Code X X XX XX

A

Significant surface:
Unless otherwise specified, inorganic finishes are applied to the entire significant surface of the part. Significant surface sare those surfaces that can be touched with a 20 mm diameter ball.

Interior masking:
Interior masking should only be done for critical functional areas. Overspecifying critical paint areas results in increasing the cost of the part needlessly.

Conveyorised finishing:
Conveyorized finishing of medium and large parts is recommended for efficiency on most (except small) parts. Design for hanging;
- Design universal mounting-points for all covers, compatiblefor one universal spraying rack
- points on a part where the part is racked will not be coveredby paint; "RACKMARKS PERMISHIBLE" should be called-up on drawing.

Drainage holes:
Allow proper drainage holes on metal parts as they must be processed through solutions for cleaning and preparation. Drainage holes on the deepest point of the product.

White colors:
White, off white and light cream colors require heavy paint thickness (2 mils instaed of 1 mil)

Spotwelds:
Spotwelds should be located whenever possible in non visual areas.

Pretreat processes:
Pretreat processes (These processes will not be mentioned in the continuation of the program):

For ferrous materials: ontvetten + iron phosphate
For plastics:no pretreat (sometimes primer)
Other materials(ZInk, Aluminium): ontvetten + primer of volgens Maynard: chromate conversion coating

Visual areas:
Crearly point the visual and the non-visual areas of the part on the drawing.

<u>Critical colors:</u>

All critical color matches should be painted in kits or sets if possible.
Viewing level specifications; most critical is "A-level", least critical is "C-level". Most parts should be specified "B-level". Mating parts should be an "A-level" to each other. Overspecification will increase piece part costs.
Do not specify the finishing specification and the color/appearance specification on the same drawing. The finishing specification contains the appropriate C/A-specification.
Only give a "A-level" match to critical visual areas on a part and give "B-level" matches to non-critical or non-visual areas.This can reduce the costs extremely.

When having two objects which have the same color specification and which are placed besides each other on the (copier-)machine then:
place them besides each others with ROUND CORNERS in staid of rectangular corners. By doing this the accent color difference can hardly be seen

2. INFORMATIE OVER VERSCHILLENDE LAAG- EN BASISMATERIALEN.

X X XX AL,X X XX CC, X X XX CF, X X XX CO, X X XX CR, X X XX KO, X X XX KZ, X X XX LO, X X XX NI, X X XX ST, X X XX TI, X X XX TL, X X XX ZI

Verschillende laagsoorten op aluminium
X X AL XX, X X AL AL, X X AL CC, X X AL CF, X X AL CO, X X AL CR, X X AL KO, X X AL KZ, X X AL LO, X X AL NI, X X AL ST, X X AL TI, X X AL TL, X X AL ZI

Verschillende laagsoorten op Ferrous Powdered Prod.
X X FP XX, etc

Verschillende laagsoorten op koper
X X KO XX, etc.

Verschillende materialen op plastics
X X PL XX

A

Preferred finishingsystems
The following are preferred finishing-systems for plastics:
(most cost effective in increasing order)

1. Molded in color texture
All resins - injection molded, thin wall foam, counter pressure foam, blow molding possible.

2. Molded in texture and a one-color coat
Material selection important due to paint adhesion
Not applicable for structural foam.

3.Molded smooth (two coat system, for color coat and textuecoat)

4.Molded smooth; three coat system, primer, color coat andtexture)

Molded in texture (1 and 2) also provide the best quality as all the texture lumps are uniform

Finishing processes

Gas counterpressure and thin walled structural foam yield a superior substrate (texture and smooth) over a conventional structural foam plastic molding. However, they still may require a color coat of paint.

Plastic materials
Coatings approved by the Emission Polusion Act (EPA-coatings) are dictated in some countries (e.g. USA).
Preferred plastics to paint with EPA coatings are most grades of ABS, Babyblend and Polycarbonates. Additives to plastics may cause problems

Polycarbonates with glass added can cause pinholing requiring an extra coat of paint (sealing)

Polycarbonates with teflon added cannot be painted.

Noryl, Prevex and Styron require primers for adhesion when using EPA approved paints.

SMC, BMC molding materials may cause paint problems due to pinholes. The pinholes are due to the pressence of glassfiber at the surface. A sealer is required.

Polyolefin plastic materials such a polyethylene, polypropylene are very difficult to paint and require special surface pre- treatments which are costly. The end result provides only marginal adhesion.

Acetal plastic resins (Delrin, Nylon) cannot be painted (no adhesion)

Glass filled materials cannot be molded to a "B"-color match and therefore usally require a coat of paint.

Visible interiors
If possible color match resin on panels that have visible interiors and eliminate painting on interior. Additional advantage - if panel color matched, chipping, wear on edges is less visible.

Molded to color
Keep in mind when designing molded to color plastic parts they may have to be one coat painted. Many parts targeted to be unpainted and up painted because of color control or blemishes in the molding pressure.

General
A clear paint overcoat may be used to hide blemishes and some defects in molded to color parts.

Plastic parts requiring painting should never contain ultraviolet stabiliser. The paint provides the ultraviolet color stability.

If possible use the same plastic resin for all covers on a given product (molded to color) to produce maximum color consistency)

Overspray should be permitted in non critical areas.

Do not design fragile bosses which have a high risk of damage during handling.

EMI/RF shielding
EMI/RF shielding is very expensive using nickel and copper acrylic paint.

Transparent parts
Clear overcoats on transparant/translucient plastics are very difficult to apply except on small surface areas. Dirt is very visible and cannot be removed (sanded) yielding a scrapp part.

E
One coat paint with molded in texture is not applicable for conventional structural foam.

Plastic parts requiring painting should never require ultraviolet stabilizer. The paint provides the ultraviolet stability.

Polycarbonates with teflon added cannot be painted.

Acetal plastic resins (Delrin, Nylon) cannot be painted (no adhesion)

Molded in texture; allow enough draft for the designated texture.

W1
Polycarbonates with glass added can cause pinholing requiring an extra coat of paint (sealing)

F1
0.2

W2
Noryl, Prevex and Styron require primers for adhesion when using EPA approved paints.

F2
0.2

W3
SMC, BMC molding materials may cause paint problems due to pinholes. The pinholes are due to the pressence of glassfiber at the surface. A sealer is required.

F3
0.2

W4
Polyolefin plastic materials such a polyethylene, polypropylene are very difficult to paint and require special surface pre- treatments which are costly. The end result provides only marginal adhesion.

F4
0.4

W6
Clear overcoats on transparant/translucient plastics are very difficult to apply except on small surface areas. Dirt is very visible and cannot be removed (sanded) yielding a scrapp part.

F6
s0.5

Verschillende materialen op RVS
X X SS XX, etc.

Verschillende laagsoorten op staal
X X ST XX, etc
X X ST ZI

Algemeen
Daar zink vrijwel steeds anodisch is t.o.v. ijzer (uitzondering: onder bepaalde omstandigheden in heet water en zeewater) beschermt het ook indien de deklaag poreus of beschadigd is. De beschermende waarde van de zinklaag is in de eerste plaats afhankelijk van de zinklaagdikte.. Een gesloten laag beschermt langer dan een poreuse laag met hetzelfde laaggewicht per oppervlakte.

Verschillende laagsoorten op zink die castings
X X ZD XX
Algemeen
Due to surface porosity, cold check and other surface imperfections primimg and sanding may be required. This is an additional expense.

E
Avoid die casting materials for decorative surfaces.

3. INFORMATION ABOUT ANORGANIC FINISHING PROCESSES

Anorganische processen algemeen
A X XX XX

Bemating
De bemating geldt voor het grondmateriaal inclusief de finishlaag.

Chemische bewerkingen
A C XX XX

A
Algemeen
Hierbij wordt langs chemische weg een metaalneerslag verkregen.

A C XX NI

A
Algemeen
This coating has excellent uniformity, resistance to wear and corrosion and is solderable under certain conditions. Although it is more expensive than standard electroplated nickel, it is often substituted on certain substrates or where size and shapes of the part present technical difficulties. Electroless nickel contains approximately 4 to 12 % phosphorous and is more brittle. It deposits slower than electroplated nickel. The deposit is hardenable by heat treatment up to HRC 69.

A D XX XX **Diffussie laag aanbrengen**

A
Algemeen
Onder diffusie verstaat men het verschijnsel dat met elkaar in aanraking gebrachte ongelijksoortige vaste stoffen op het grensvlak met elkaar vermengen t.g.v. de ongeordende warmtebeweging van de moleculen of atomen van deze stoffen. Daardoor is de diffussiesnelheid afhankelijk van de temperatuur. T.g.v. deze vermenging kunnne als secundair verschijnsel verbindingen ontstaan. Het in de ondergrond diffunderende bestnddeel kan zowel een metaal als een niet-metaal zijn.
Diffusie van metalen wordt uitgevoerd om het metaal oppervlak een andere samenstelling te geven; hierbij ontstaat dus steeds een legeringslaag. Bekende diffusieprocessen zijn het diffunderen van zink en staal

Electrolytische processen
A E XX XX

A

Algemeen
Hiertoe behoren alle processen van een electrolytische metaalafscheiding op een ondergrond, onafhankelijk of het metaalneersalg samen met de ondergrong wordt gebruikt of dat het ervan wordt losgenomen. Hiertoe behoren dus NIET de

electrochemische oxidatie processen, zoals het anodiseren van aluminium en ook niet het electroforetisch lakken.
In de overgrote meerderheid van de gevallen wordt galvanotechniek uitgevoerd in een tank met een galvanische badvloeistof, meestal een waterige oplossing van zouten, zuren, basen of combinaties daarvan, waarin een of meer kathoden en anoden zijn geplaatst die verbonden zijn met respectievelijk de negatieve en de positieve pool van een gelijkstroombron.

E

Het ingangsmateriaal moet stroomgeleidend zijn.??
Kunt U aan deze eis voldoen ?

W1

Binnen kooien van Faraday zal de zinklaag veel minder dik zijn. In een dichte kooi bedraagt de laagte plus minus 10 % van de laagdikte buiten de kooi. In een open kooi bedraagt de laagtedikte plus munis 60 % van de laagdikte buiten de kooi.

Vermijd scherpe hoeken, gesloten kraalranden, spitse punten, nauweblinde gaten, smalle gleuven en alle constructies die kunnen vollopen en volzuigen en door spoelen niet effectief gereinigd kunnen worden.

F1
0.5

W2
Kunnen er zinkbadjes achterblijven ?

F2
0.75

W3
Heeft het ontwerp scherpe hoeken, gesloten kraalranden, spitse punten ?

F3
0.75

W4
Heeft het ontwerp nauwe blinde gaten, smale gleuven of constructies die kunnen vollopen of volzuigen en die door spoelen niet effectief gereinigd kunnen worden ?

F4
0.75

Electrolytisch proces op aluminium

A E AL XX, A E AL AL, etc

A E KO XX Electrolytisch proces op koper

A E KO AL t/m ZI m.u.v. CC,CF,CO

Zo alle electrolytische codes

Electrolytisch proces op staal

A E ST XX

A

High strenth steel

All electroplated high strength steel parts (0.3 % carbon and over) which are heat treated and/or work hardened to Rockwell C30 hardness or above shall be baked after plating to reliev hydrogen embrittlement. To accomplish this, the designer shall specify the following note on all parts subject to hydrogen embrittlement:

BAKE WITHIN 3 HOURS AFTER PLATING AND PRIOR TO ANY SUPPLEMENTAL TREATMENTS FOR 3 HOURS MINIMUM AT 190 DEGR.C +- 14.

Hydrogyn embrittlement

Warning:

Electroplating, electroless plating, electropolishing may result in hydrogen embrittlement. For critical applications the designer should consider alternate finishes, e.g. 50-0506 or 50-0537, if the design permits

A E ST CR 0009

A

Algemeen

Hard chromium electroplating is inherently rough and lacks the brightness of decorative chromium. It is intended primarily to take advantage of the metal's hardness, resistance to heat, low coefficient of friction, high resistance to impact, abrasion and corrosion. Thickness of application for optimum wear and corossion resistance ranges from 13 um to 25 um, but if required, thinner or thicker applications are possible. Corrosion protection is fair to good but incidental to the primary function. Additional corrossion protaction can be obtained by use of an electrodeposited nickel undercoat. Very close dimensional tolerances can be met by overplating and grinding to size. A deposit over 25 um thick is required before chromium will assume it's true hardness charasteristics when used over an unhardened basis metal. Over a hard base metal, the thickness is not critical. Hard chromium plating should not be used as a general substitute for hardening. Resistivity is 14-66 micro omega/cm. Maximum operating temperature is 200 degrees Celsius.

A E ST CR 0010

A

Algemeen

Bright chromium (MN 50-0010) is a protective decorative coating system in which the outer most layer is chromium. It is used both for the corrosion and abrasion protection, but primarily for its decorative/aesthetic appearance.

A E ST ZI 0006

Put on drawing MN 50-0506 as an alternative. Manufacturer can then decide for the most economic finish.

A E XX NI

A

General:

It is used for corrosion protection of internal parts subjected to wear or abrasion, maximum temperature above that recommended for zinc plating or where the more attractive appearance is desirable but a closely controlled color or appearance is not required.

Coating thickness is 5 to 10 um for general and 3 to 7 um for threated parts. Resistivity is 7.4 to 10.8 in micro-omega/cm

A E XX ZI

A

Algemeen

Galvanisch aangebrachte zinklagen bieden een goede corrosiebescherming waarvan de duur vrijwel evenredig is met de zinklaagdikte. De toegepaste laagdikten kunnen uiteenlopen van 5 um tot 40 um. Het aanbrengen van grote laagdikten is technisch goed mogelijk maar meestal niet economisch.

Door na het verzinken een passiveerbewerking uit te voeren kan de corrosieweerstand belangrijk worden opgevoerd. Dit is vooral bij dunnen lagen van belang.

Doordat er geen legeringslaag aanwezig is is de corrosieweerstand beter dan bij thermisch verzinken.

Spuitbewerkingen
A S XX XX

W1
Reverse flanges are very difficult and costly to paint

F1
0.25

W2
Deep recesses are difficult to paint, in addition the top surface area around the recess will have excessive paint (runs, sags,blisters etc). Avoid if possible. If not possible, the larger the opening of the recess, the easier the surface to paint.

F2
0.25

Thermische bewerkingen

A T XX XX
A
<u>Algemeen</u>
Thermische deklagen worden verkregen door het te bedeken metaal onder te dompelen in een bad van een gesmolten ander metaal dat de deklaag moet vormen.
Door de hoge temperatuur kan trekken van het werkstuk optreden. In veel gevallen moet de constructie van het werkstuk worden aangepast aan deze bewerking.
Laagdikte is nauwelijks instelbaar.
Grote vullende werking. (Dit is een nadeel voor b.v. schroefdraad)

Verder is de samenstelling van het staal van invloed op het eindresultaat.

3. ORGANISCHE DEKLAGEN

O X XX XX

A

Bemating

De bemating geldt voor het grondmateriaal exclusief de finishlaag.

Dual colors

Dual colors on a single piece part is expensive since masking is required. Consider separate parts that are snapped together.

Apply textured paint specifications to avoid dust inclusion and irregularities.
But, when texture paint is required, zone only appearance areas.

Deep recesses are difficult to paint, in addition the top surface area around the recess will have excessive paint (runs, sags,blisters etc). Avoid if possible. If not possible, the larger the opening of the recess, the easier the surface to paint.

O X PL XX

A painted texture will match a molded in texture plastic standard to no better than a "B-C level" match depending on texture.

One coat of paint over a molded in texture will match to a molded texture (unpainted) no better than a "B-level" match. Do not combine for adjacent critical visual parts.

The other codes are: O X NF XX and O X ST XX .

4. CONVERSIELAGEN

C X XX XX

A
Onder conversielagen verstaat men anorganische deklagen die op een metaaloppervlak worden gevormd door de inwerking van een chemisch agens, waarbij het metaal zelf meewerkt aan de vorming van de laag.
De vloeistof, waarin het proces plaatsvind, bevat bestanddelen die aanvankelijk een deel van het metaaloppervlak oplossen. De opgeloste metaalionen reageren direkt daarna met bestanddelen uit de vloeistof zelf en vormen zo het neerslag.

Bekende conversielagen zijn fosfaatlagen op staal, chromaatlagen op diverse andere metalen alsmede het anodiseren van aluminium.

Fosfaat en chromaatlagen, die als ondergrond dienen voor organische deklagen op staal, aluminium, zink, cadmium, koper en magnesium vormen het voornaamste toepassingsgebied van de conversielagen.
Een conversielaag onder een organische deklaag heeft twee functies:
1. Verbetering van de verfhechting
2. Voorkomen van ondercorrosie

C X AL XX **Conversielagen op aluminium**

C X AL OX

A

Anodising aluminum is an electrolytic oxidation process used on aluminum (and alloys) in which the surface of the metal is converted to a coating having desirable protective, functional or decorative properties. The oxide coating is integral with the aluminum, and has excellent adherence. As formed, the anodised film is a honeycomb network of cells. Porosity of the film allows coloring or impregnation of the coating either by additions to the anodising electrolyte or by post treatment. Undyed anodising is achieved by sealing the porosity with pure water at temperatures ranging from near boiling to live steam for various processes

C X AL OX 0013

A
General:
Hard anodising produces a dense, very hard (400 HV min.) wear resistant surface. Thickness of coating is 50 um unless otherwise specified.

Critical fit:
In applications where fit is critical manufacturing allowance must be made for growth of approximately 33 % of the thickness of each coated surface

Eis:
This coating is unsuitible for alluminum alloys containing large amounts of copper or silicon.

Appendix 11:
Programming and Test plan for further development of 'INFOFINISH'

In this appendix the estimate is given for the needed programming and testing time.

Prgramming and testing time for:

Mainprogram	INFOFINISH	2 days
Subroutine	KINFO	4 days
	USERREQ	4 days
	REDSPE1	4 days
	SHOWFS	2 days
	REDSPE2	2 days
	VALUE	4 days
	ARRANGE	4 days
	INFOCHOICE	2 days
	INFOPROC	4 days
	INFORM	2 days
	SHOWREQ	2 days
	SHOWGEN	2 days
	SHOWQUA	2 days
	SHOWCOS	30 days
	PRESENT	4 days
Subroutine	SPECINFO	10 days
Subroutine	PROCINFO	10 days
Subroutine	UPDATE	10 days
		----------- +
		Programming and testing time: 104 days

Creating the files SPEC and PROC	10 days.
Conversion of data	30 days.
	-------------- +
Total programming and testing time:	144 days equals 5 months .

If we put 20 % on it, in order to be careful, then the total programming and testing time would amount to 7 months.