Information generated and/or used during product and process development.

May 1996.

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Key words: Engineering Data Management (EDM), Industrial Design Engineering, Automotive Suppliers, Metamodel, Product Data Management (PDM).

INTRODUCTION.

Objective and scope. An issue on the improvement of product and process development processes is an optimal information supply. Therero a doctoral research project - started in 1992 - aims to determine and chart which information, created and/or used by the industrial design engineering discipline, should be available and where and when and how. Based on these findings the product development process can be improved by adjusting it to the information requirements. This project is being carried out in co-operation with industrial partners that functions as a sounding board.

Some preliminary results of the research project leading up to the dissertation planned at the end of 1996 will be presented. These preliminary results include examples of engineering and product information and the related development process, as well as the way these examples are structured (metamodel) and also a tool in which the metamodel is incorporated.

Approach. Information on product and process development projects at three automotive supplier companies was analyzed. The analyses resulted in three company-specific models, see figure 1. Based on these analyses a more generic example model was created, derived from the situation at the three companies.

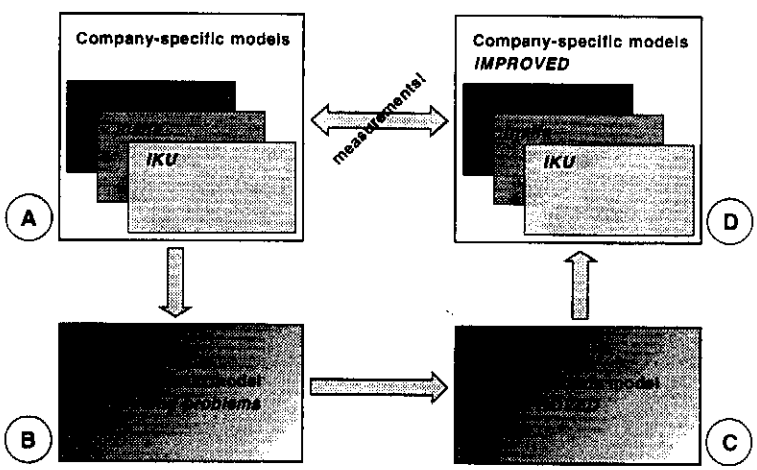

Figure 1. Research cycle.

Because it was not known whether the results would have some measure of generality, it was decided to start with a selection of companies that produced a similar product and had a similar process development process. The selected companies were automotive suppliers that engineer and produce products - including mechanical and electrical components - to order.

METAMODEL

One of the problems in this research was the lack of an appropriate model to store and represent the relevant aspects of the company-specific and the more generic models. To this end we have developed a metamodel. The metamodel should include the development process and the information structure, the users and producers of information, the time consumed in the development process, the systems used and, what is more, also the relationships between all these aspects. Furthermore the metamodel has to be simple and explainable, in order to achieve overview and insight.
In Roozenburg et al. [9] the relationship between method and organisation is explained. The structure in the metamodel is derived from this explanation. The building blocks of the metamodel are (see figure 2):
1) Subject: the acting systems, e.g. a man or a department;
2) Activity: the processes;
3) Information: the system treated: the information used or created in the activities.

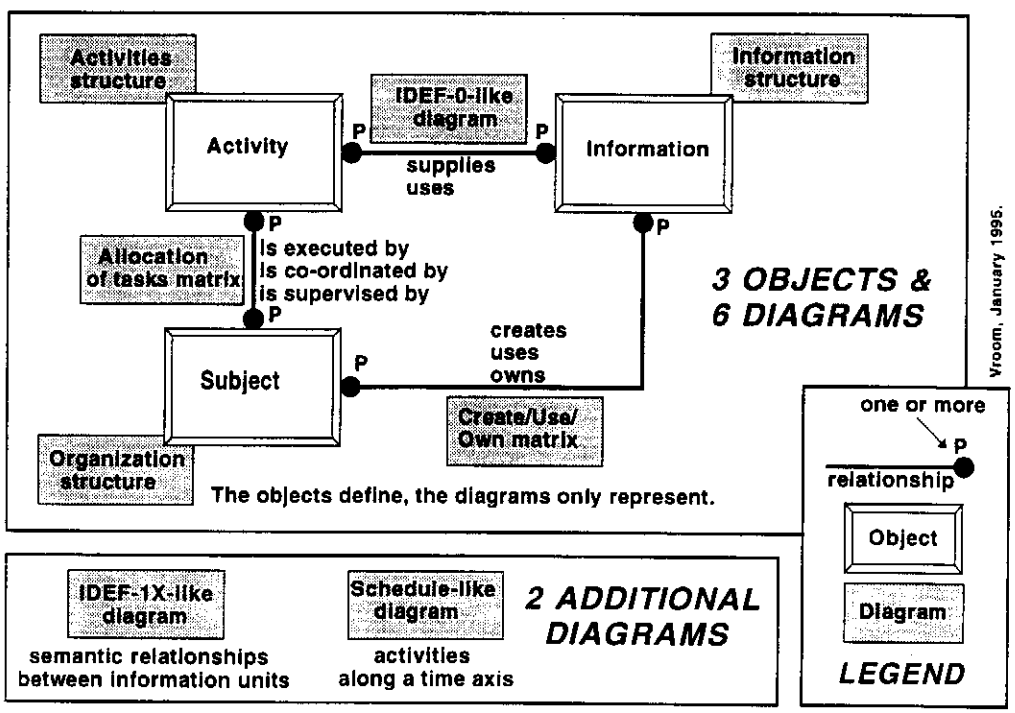

Figure 2. Metamodel for the development process: Three objects to store & eight diagrams to represent.

The building blocks are regarded as database objects and are modelled in an object-oriented way in which attributes and relationships between the blocks (database objects) are defined. With these objects and relationships, a three-dimensional model of the development process is created in which each block is regarded as a dimension. This three-dimensional model is a complex model that does not give sufficient overview of the development process and related information. This is why graphical diagrams are used. Three diagrams are to depict for the relationships within the objects (one-dimensional):
- Organization structure (relationships within the Subject object);
- Activities structure (relationships within the Activity object);
- Information structure (relationships within the Information object).

Three others represent the relationships between the objects (two-dimensional):
- IDEF-0-like diagram (relationships between Activity and Information);
- Create/Use/Own matrix (relationships between Information and Subject);
- Allocation of tasks matrix (relationships between Activity and Subject).

To complete the charting of a development process, two additional diagrams are required (see figure 2). The first six diagrams mentioned can be generated automatically from the contents of the three objects.

The metamodel is discussed more extensively in [13] en [15]. In this notition only the information object is described shortly as an example.

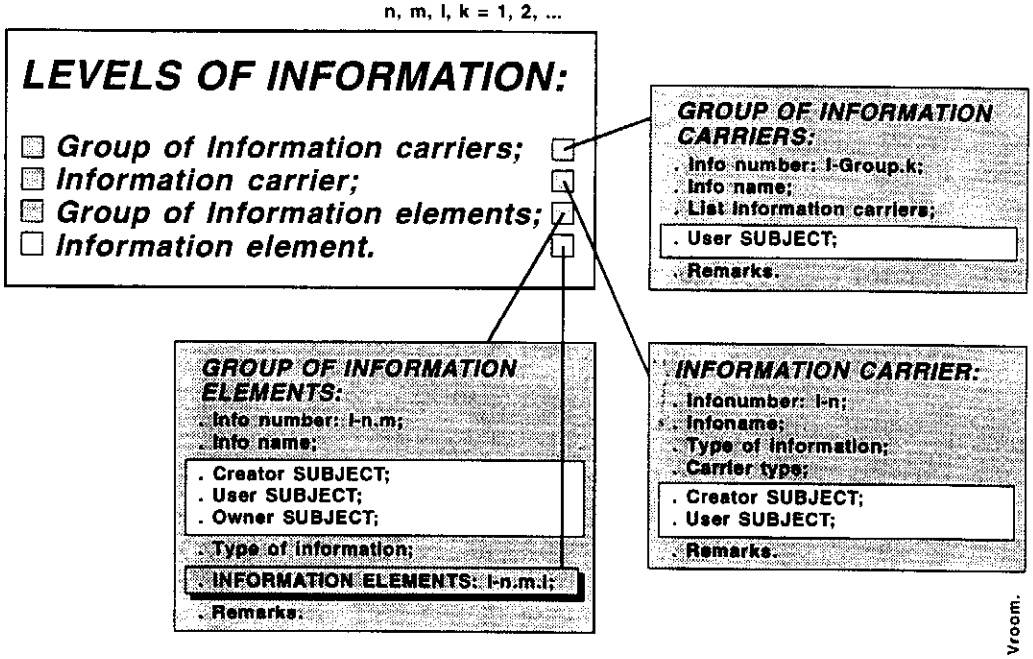

Figure 3. *The levels of the Information object.*

The Information object is subdivided into four levels (figure 3): Group of Information Carriers; Information Carrier; Group of Information Elements and Information Element. An Information Carrier is considered a useful collection of "Groups of Information Elements". For example, in the information carrier "Packing instruction document" (I-39 in the example model) there are three "Groups of Information Elements", namely:

I-39.1 A list of packing materials;
I-39.2 The packing instructions themselves;
I-39.3 A heading, which serves as an identification of the document.

A "Group of Information Elements" consists of several "Information Elements". For example the Group Heading (I-39.3) consists of the following "Information Elements":

I-39.3.1 Product identification code;
I-39.3.2 Name of product;
I-39.3.3 Number of products per box;
I-39.3.4 Number of boxes per pallet;
I-39.3.5 Stock number;
I-39.3.6 Name of person who wrote the packing instructions;
I-39.3.7 Approval signature and
I-39.3.8 Release date.

To characterize the information, the attribute "type" is used in the information object. With this attribute the following types of information can be distinguished, each of which has to be managed differently (see also figure 4):

Type i1 is the design rationale: the arguments and reasons for taking design decisions.
Type i2 is the information that describes or defines the product and process design (the design dossier).
Type i3 is library information in which knowledge of experts is included. This is the information that can be found in catalogues or databases or acquired from experts.
Type i4 is information which is relevant to the project manager and includes information about costs, time consumed and milestones reached in the running project.

As figure 4 shows, these information types are used to distinguish product data from engineering data. The criteria that are helpful in distinguishing the various types of information are: if it is not specific to the running project, it is type i3; if it is information concerning the project instead of the product and process design it is type i4; if it have to be accessible only to the engineering department, it is type i1; type i2 is specific to the running project, and not only of interest to the engineering department but also to other departments, and it concerns the product and process design and not the project management. These criteria make clear that the different types of information have to be managed differently.

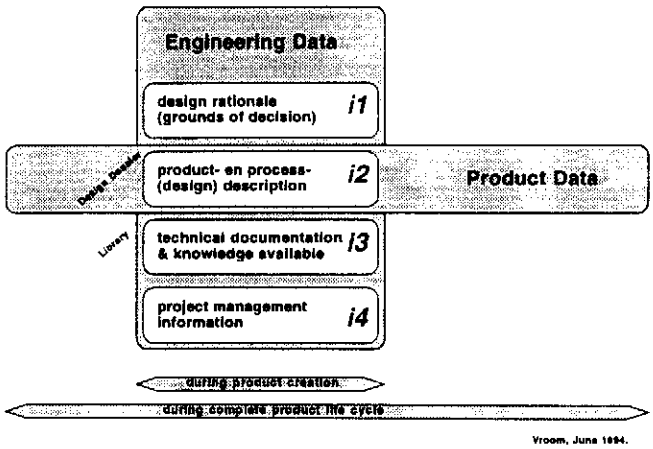

Figure 4. Types of information.

The relationships within and between the objects, the diagrams and the tool. The relationships within and between the objects are represented by the identification codes and by the attributes at the different levels of the objects. That is why six diagrams can be generated automatically from the data included within the three objects. Therefore, a software tool has been developed to ease and accelerate the use of the metamodel and its objects and models.

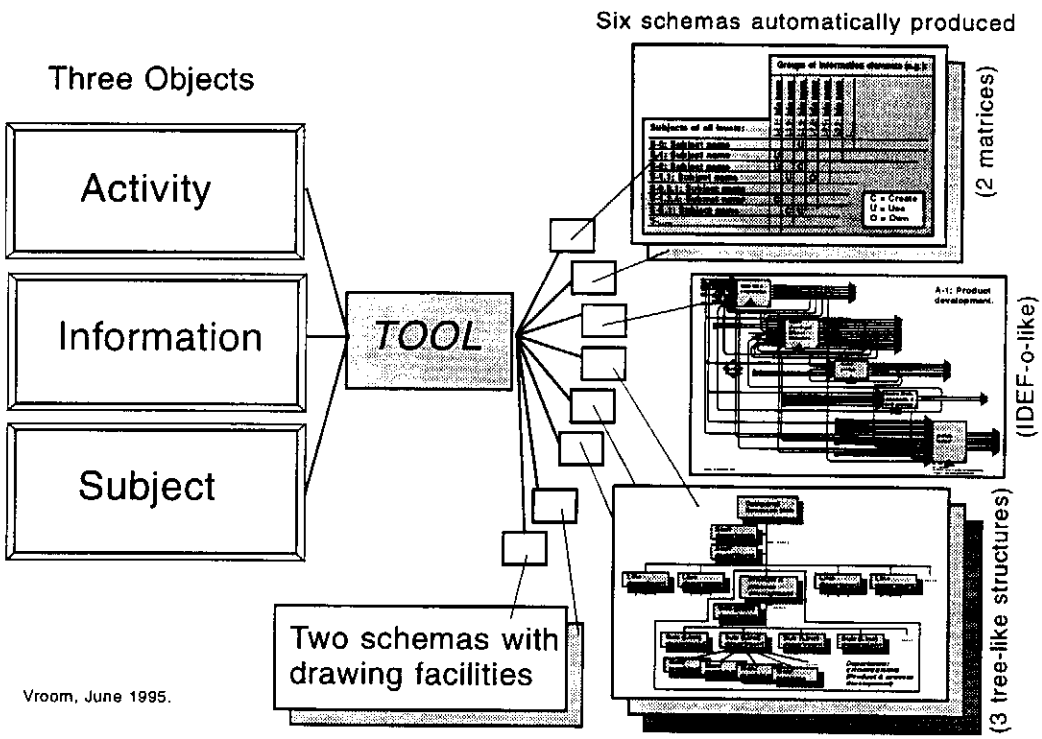

Figure 5. Graphical database presentation tool.

The main function of the tool is to clearly present the contents of the objects in a database. For that reason it is called a "Graphical database presentation tool (GDPT)". The tool was developed using NextStep and the prototype has been in use since July 1995. The tool consists of a metamodel editor, a database editor, a query tool and a diagrams generator.

CREATE A COMPANY SPECIFIC MODEL USING THE METAMODEL

The people within a given company appeared to have different views on the various aspects of product and process development. This is why it is hard to determine a consistent representation of the company's development process and its related information. Because it is an explainable model of a company that is required, the model has to be consistent. For this reason the model is created iteratively as below:

- make a list of the information carriers;
- describe the product and process development process;
- following the metamodel, structure the product and process development process;
- identify the required and delivered information for each activity;
- check if all information carriers mentioned in the activities are included in the information carriers list;
- check if all information carriers are created in the activities or that it is correct that those are created outside the area of interest. If not, than add activities.
- do the same for the use of information carriers.
- determine the subjects in the company (departments and so on);
- determine who is responsible for the activities and who carries them out.
- identify the people and departments that use, own and create the information carriers on the list;
- check if all departments and people mentioned in the activities or on the information carriers are on the subjects list. If not, fill up this list.
- cross-check the two two-dimensional relationships in which the subjects are involved: check if the subjects mentioned as users of an information carrier are also mentioned together in one activity or that it is correct that this is not so. If not fill up the relationships. The other way round: check if the subjects mentioned in the activities also are mentioned in the relationships of the related information carriers of that activity or that it is correct that they are not. Otherwise, fill up the relationships.

Usually, after these checks and the appropriate action the model is consistent.

Two approaches. There are two options to describe the product and process development process by using the metamodel here presented, that have been tested out in a field situation. The first option describes the process by using minimal activities and information parts. This is done by the maximum possible grouping. For example, one can include only one type of order form. The order form is used to order the complete development of a product, but also to order a prototype, or a tool and so on. The second aims for a logical description, in which, for example, several order forms are identified, such as an order to make an A sample, an order to test a B sample, and so on. In the latter approach the information contents is taken more into account. A disadvantage of the latter approach is the number of documents to be included in the database. To illustrate this statement: one instance of the metamodel created when using the first approach to describing the process comprises about 75 Information Carriers; about 250 Groups of Information Elements and about 1500 Information elements. The second approach resulted in an instance of the metamodel (database) comprising about 175 Information Carriers; about 500 Groups of Information Elements and about 3000 Information elements.

EXAMPLE OF THE ACTIVITIES PART AND THE INFORMATION PART

Figure 6 gives an example model of the activities part, figure 7 for the information part.

For a company's central information management system, the Groups of information elements are the building blocks of the systems contents. For the complete system, only one standardized heading is required instead of the various headings found on the information carriers. The specific parts of the headings are included in the Groups of information elements. The Groups of information elements will be grouped onto information carriers.

The standardized heading could include: project code, project name, author name, product name, customer name, customer project code, date, copy addresses and remarks. More specific headings are, e.g., part number, part name, drawing number, legend, approvals and so on.

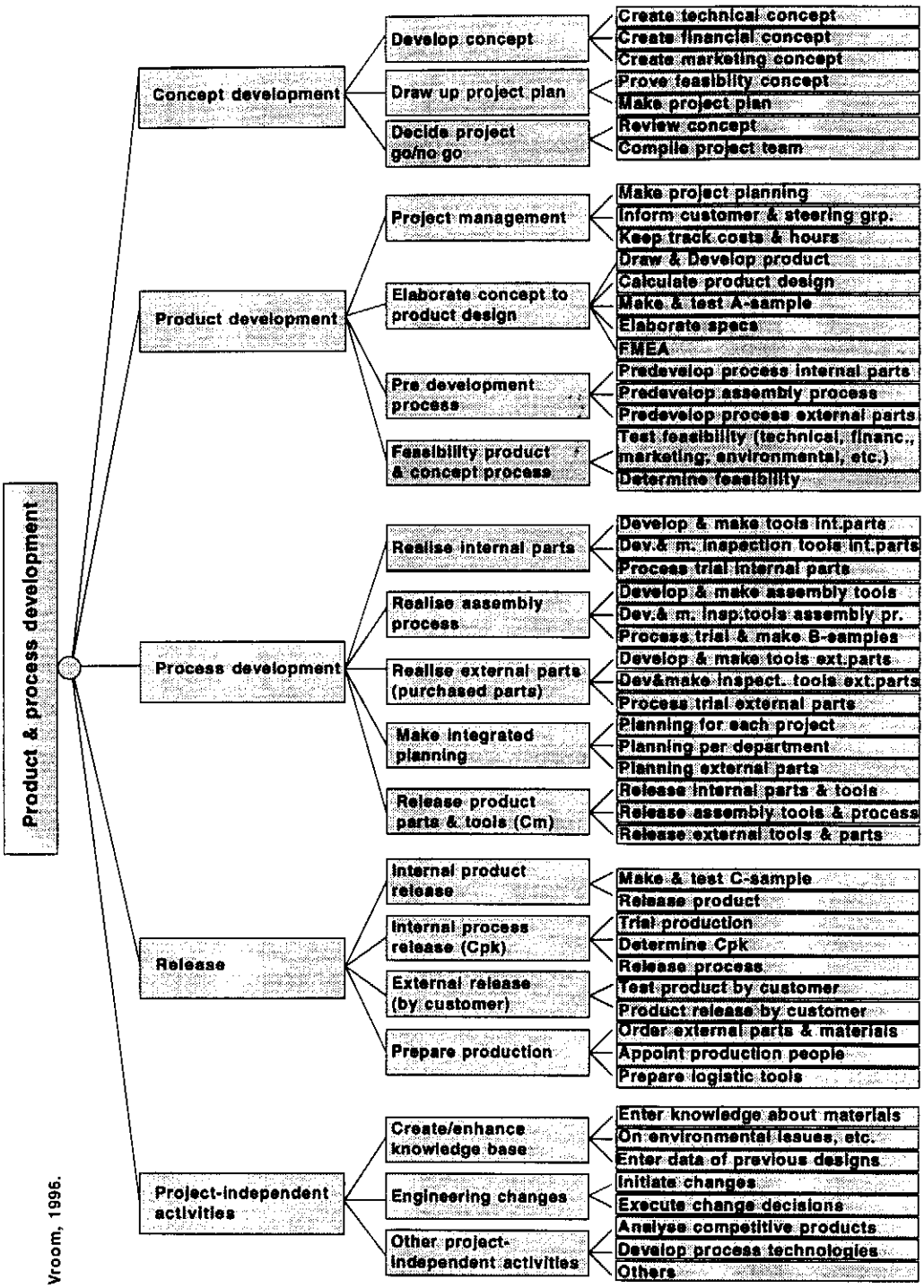

Figure 6. General example model for the activities part.

However, because of the magnitude of the Group of information elements level (about 250 - 500 groups), this article will suffice with describing the small (i.e. according to the first approach to describing the product and process development) preliminary contents of the Information carrier level. In figure 7, the information carriers are grouped into the four types of information.

The company's organisation appeared to be the most company specific of the three parts (information, activities and organisation). But it was good to discover that the generality of the activities and information parts did not suffer much from the company specificity: the activities and the information are pretty stable for this type of product and process development.

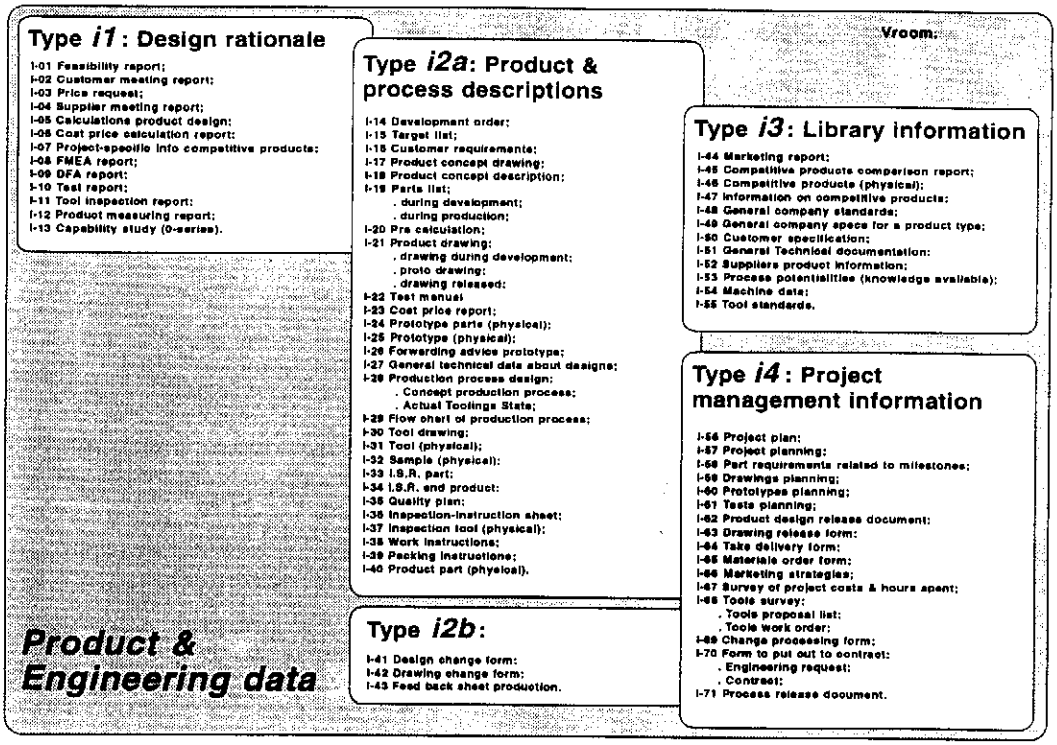

Figure 7. Preliminary general example model of the information part.

EVALUATING AND CONCLUDING REMARKS

A more extensive discussion on this subject will be published in [15].

Usefulness of metamodel. The diagrams help the companies to obtain an overview of and insight into the complete process of product and process development. The diagrams contribute to the identification of consequences of changes in the working method.

It takes about three months to depict a company this way. After the description of the current company model, an improved model is created. This step is valuable in preparing a company for the introduction of Product Data Management (PDM) systems. The concept of PDM systems is useful after a company has modelled (improved, organised) the information items and activities within the development process. This first step is often neglected and this has a poor effect on the PDM system (the automation of a poor process).

The tool. The tool that has been developed has proved that the diagrams can be generated automatically. Even when the metamodel is edited (the metamodel is somewhat flexible in order for it to be appropriate for different companies). The actual version of the tool does not take over all changes in the metamodel for the generation of the diagrams. This will be, however, feasible in a next version.

Information management. Four types of information are distinguished. These types have to be managed differently: project-specific or not, accessible to the whole company or not.

It appeared to be not feasible to fully complete a model for a company. For instance there will always be some users of information elements that are not described in the model. In addition companies tend to frequently reorganise. This is why it seems more effective to enhance the availability of product information than to adjust the working methods and organisation to the information needs. For this, a PDM system could be a useful tool. This does not imply that a company should no longer be aware of the information operations. Because this knowledge is valuable for good clustering of information, and to prevent more information from being generated and circulated than is required for a good product and process development project.

Others. The activities part and the information part of the metamodel are fairly stable for the type of company covered in this research. The organisation part is very changeable.

The metamodel is a generic frame to realise company-specific improvements of product and process development. In the end, companies themselves are the only ones that are able to improve their own product and process development. The value of this research is to offer enabling tools. These tools are: the -somewhat flexible- metamodel, the software tool DPT, example models and guidelines on how to apply these tools. A generic model is not required. Two -to some extent- general example models are sufficient to illustrate differences and similarities between companies and will help companies to reconsider their own development process.

ACKNOWLEDGEMENTS

I wish to acknowledge the helpful comments during the research period from university colleagues N.F.M. Roozenburg, P. de Ruwe, Dr. H.G. Sol, Dr. J.S.M. Vergeest, A.P. Bremer and of the members of the industrial sounding board group T.H. Mandemaker, A.A.M. Ranke, W.G.A. Collaris, P. van Rijn, R.A.M. de Zeeuw, J. de Jong, T.R. Selling and H.J. Groeneveld, and to acknowledge the ready cooperation of people from the automotive supplier companies, especially M.W.M. Nabuurs, P. Schmeitz, R. Hoogenboom, H. van Savooijen and B. ten Hulscher. And further to acknowledge the support of the meetings of the industrial sounding board arranged by the external project coordinator L. Zuijdgeest (PDI/CALS center).

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Appendix: Some explanation about the contents of the information carriers mentioned:

I-03 Price-request: Information request of Engineering to Purchase about prices of components, toolings, etc.

I-07 Information about competitive products (project specific): This information includes all information about competitive products that is available and relevant for a specific project.

I-10 Test report: The results of testings.

I-13 Capability study: The Capability Study is the Measuring state of products from the 0-series, supplied by data about the process used.

I-15 Target list: list of the target price per part and the target price per tool.

I-16 Customer requirements: Customer requirements are the project-specific requirements for the product to be developed. Customer specifications are the general specifications which are valid for all products of the customer. Requirements include references to the specifications.

I-22 Test manual: The Test manual comprises descriptions of the tests to be performed. It includes a description of the measuring equipment (name, range, resolution, accuracies) and a description of the state of the tests (during which phase in the development process, at which model). Per test there is a heading (test number, customer reference to specifications, issue, date) and a description of the test with the required equipment and the related requirements and/or specifications.

I-26 Forwarding advice: Describes the packing of a prototype: packing (box, case, tube), quantity, type, dimensions, weight, contents.

I-27 General Technical Data about the designs: This report includes the remaining data, required to produce the designed product. For example: information about the glue to be used.

I-28 Production process design: The document "Production process design" is created during the development of the process. In the beginning it only includes remarks about processes, quality plan, customer data, tools and so on (Status 1: Concept production process). Further in the development phase (Status 2: Actual Toolings State), it includes article descriptions (article code number, article name, drawing number, location, date); parts descriptions with the tooling description, material description, position, material code, quantity and unit; tooling (number of tooling, description, cost centre, instruction, price, department, standard time initialisation, standard time tooling); remarks about packings; status drawing/product and quality instructions.

- Status 1: Concept production process;
- Status 2: Actual Toolings State.

I-35 Quality plan: The Quality plan lists all toolings which have to be checked and all checkpoints which have to be measured during production. It includes measuring equipment and frequency of the measurements. The Quality plan is an overall plan including specifications.

I-36 Inspection-instruction sheet: is the definition of the inspection tool.

I-38 Work instructions: The work instructions describe the step by step activities for the operators of the machines and the points of attention for the operators.

I-41 Design Change Form: For each design change, a "Design change form" is filled in, but the product design drawing is not adjusted for each design change. The design change form includes: cause for change; description of change and consequences for prices and approvals for change (date change on product drawing, reference to change number, signature).

I-42 Drawing Change form: At some changes of the design, the drawing is adjusted. The "Drawing Change form" is meant to store which design changes are processed in the new drawing.

I-44 Marketing Report: made after a visit or an exchange or a research. These reports are not made specifically for a certain project.

I-45 Competitive products comparison report: Comparison conclusions regarding the constructions and the specifications of competitive products and results of tests with these products.

I-47 Information about competitive products (general, not project-specific): Pictures, brochures, etcetera and a discussion of the remarkable issues (remarkable in qualities or in specifications of competitive products)

I-49 General company specifications for a product type: This information is used by the sales department for selling

product types which will be customized afterwards.

I-50 Customer specification: Customer specifications are the general specifications which are valid for all products of the customer (compare I-18: Customer requirements). Customer specifications include a list of related documents and a description of the specifications (scope, objective, drawing requirements, legal and safety requirements, development phases, testing requirements relative to build phase, worst case tolerance, durability test, component tests, assembly tests, trim and hardware tests, vibration tests, electrical tests, product assurance, vehicle evaluation tests, reliability, fit and finish specifications).

I-51 General Technical documentation: Technical Documentation is divers. It includes: Literature, articles; International standards (DIN, ISO), etcetera.

I-52 Suppliers Product information: Catalogues of suppliers and so on.

I-53 Process potentialities: This might also be knowledge available at the suppliers for instance.

I-54 Machine data: Information about the machines available.

I-55 Tool standards: Description of general tool standards and special standards per tool type.

I-56 Project plan: Description of the project including conditions (name of customer, activities, relevant customer specifications); targets (costs of development, product price, investments in tools); key dates drawings (prototype drawing, product drawing, assembly drawing); key dates deliveries of models (1st & 2nd prototype delivery, samples, ISR); members of project team; approval manager Engineering (name, date & signature).

I-58 Part requirements related to mile stones: Table in which the steps of the process are scheduled.

I-60 Prototypes planning: Parts lists for prototypes (part names & numbers, product number) and per part: how, when and by whom the part will be made and the material of which the part will be made.

I-62 Product design release document: This document lists the check-points (safety requirements, technical specification, F.M.E.A., D.F.A., calculation, drawings) required for release and comprises the approval signatures.

I-63 Drawing release form: Using a release-memo, departments are informed about releases of drawings.

I-64 Take delivery form: This form is used to state that goods are received. It includes the article description (article code, quantity, description), the invoice-price and administrative data (cost centre, internal order-number, date of approval, approval initials, date booked, booked initials, date of receipt, stock location numbers, method used for measuring, signature for receipt of the goods).

I-66 Marketing strategies: Plans about new products to develop, made by the Marketing and Engineering.

I-68 Tools survey:

- Status 1: Proposed Tools List;
- Status 2: Tools Work Order.

The Proposed Tools List is a predecessor of the Tool Work Order. The Tool work order is a form to fasten down the tools required for production of the product design. It includes data about agreements on tools (cost price, sale price, order number customer, quotation request number, agreements on payment, number of samples for customer and/or company, delivery time samples, delivery time first production series, total series, yearly series, product series); particulars regarding: tools, packing, product, remarks; approval of responsible person and of person who performs the task (initials and date).

I-69 Change processing form: Form to initialize the changes approved. Argument for change (of tools), remarks: delivery dates (samples customer/company according to code number (quantity, date), first product series (quantity, date); data about product change (date of introduction), data former product (use somewhere else, convert into scrap, etcetera), data about deliverability of former product (regarding production, regarding service).

I-71 Process release document: This document lists the check-points required for process release, the activities performed and activities to be performed and comprises the approval signatures.

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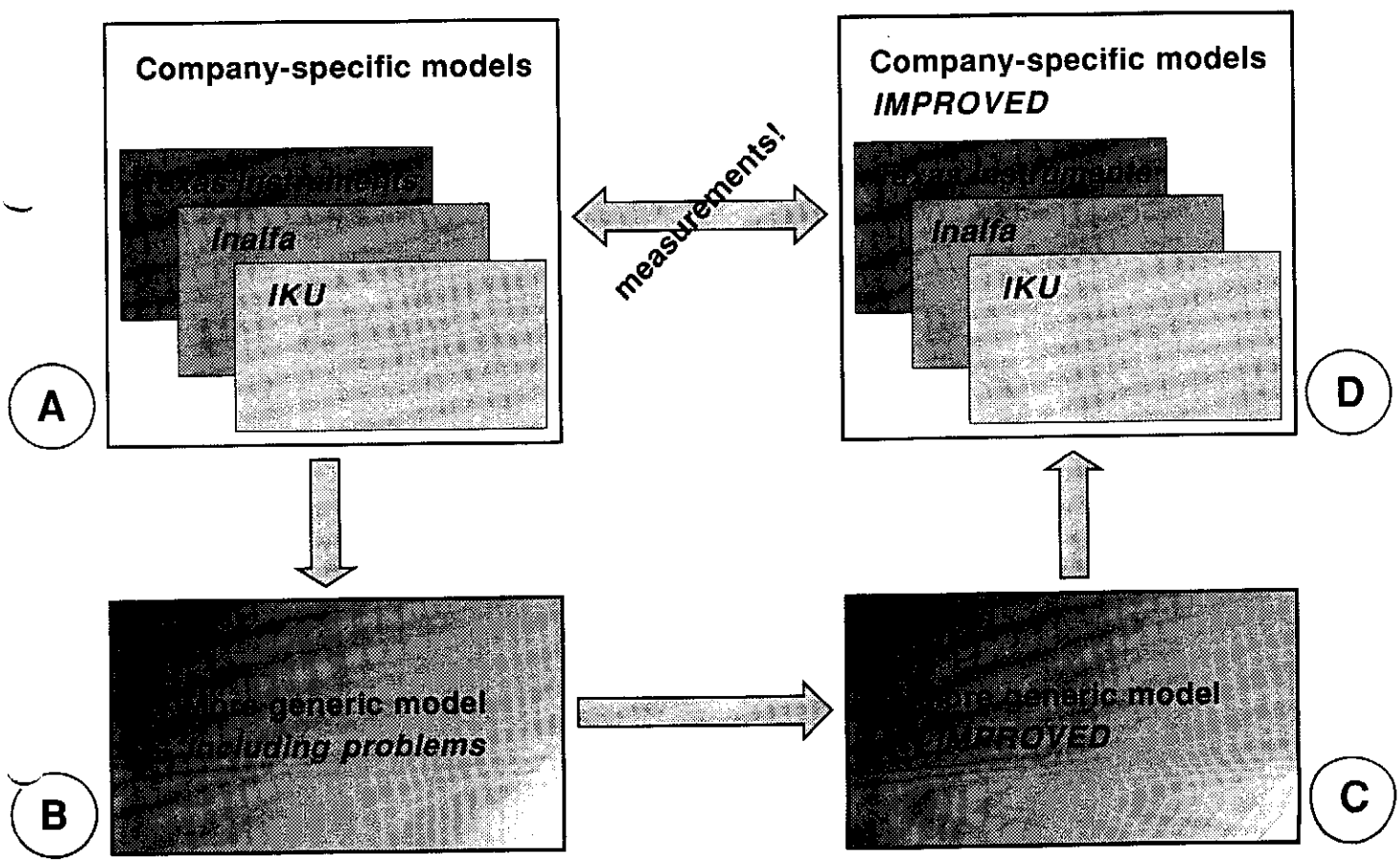

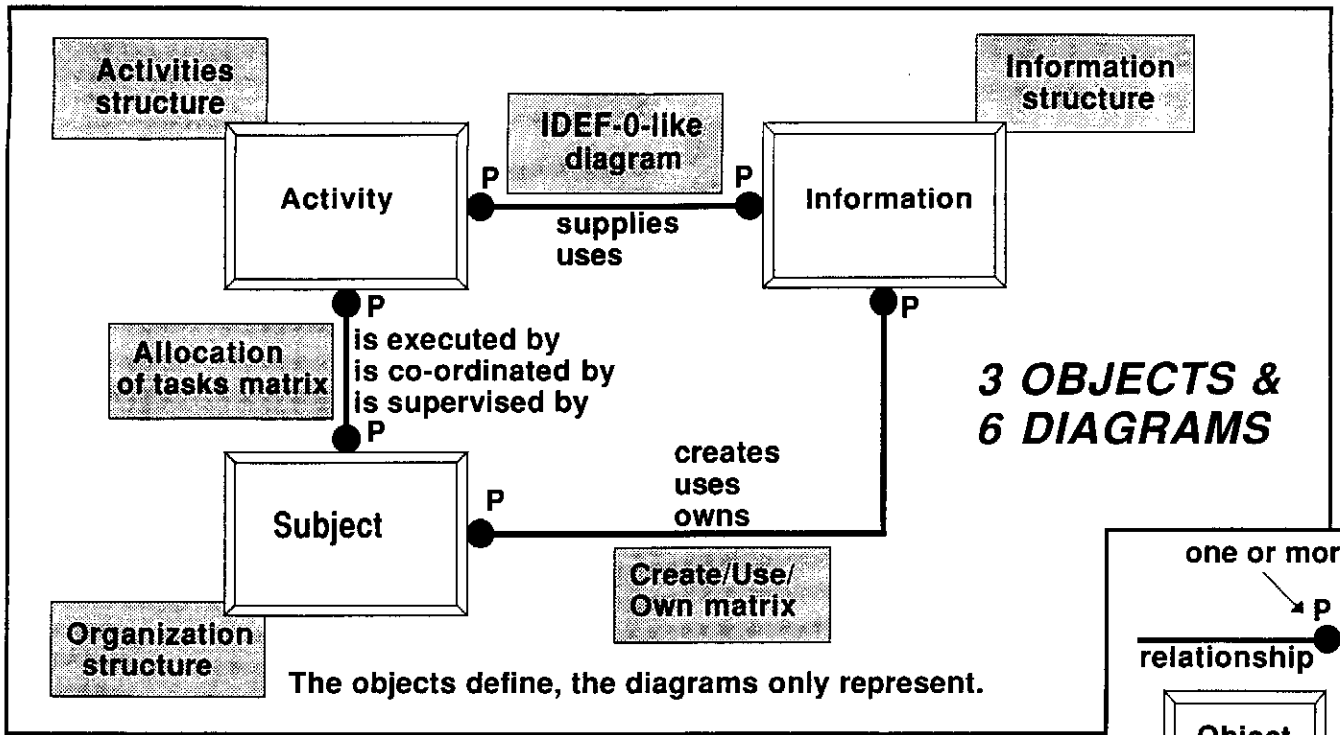

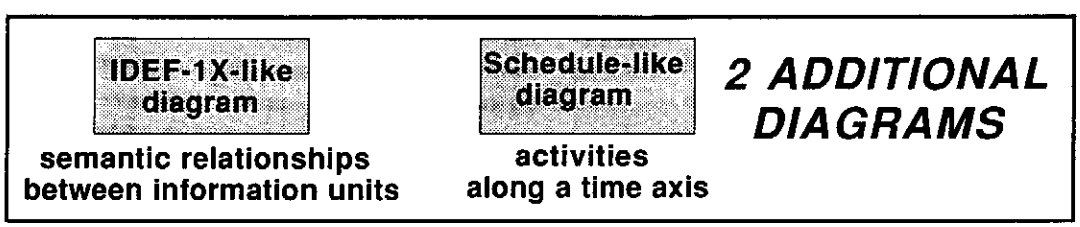

LEVELS OF ACTIVITY:

- Area of analysis;
- Subdivision;
- Procedure;
- Task;
- Activity or decision (no attributes).

n = 1, 2, ...
m = 1, 2, ...
l = 1, 2, ...
k = 1, 2, ...

AREA OF ANALYSIS:

. Activity number: A-0;
. Activity name: DEVELOPMENT;
. Responsible SUBJECT;
. Executive SUBJECT;.
. Duration (min - max);
. Remarks.

SUBDIVISION OF THE ANALYSIS AREA:

. Activity number: A-n;
. Activity name;
. Responsible SUBJECT;
. Executive SUBJECT;
. Duration (min - max);
. Remarks.

TASK:

. Activity number: A-n.m.l;
. Activity name;
. Type;
. Purpose;
. Tool (computer software);
. Responsible SUBJECT;
. Executive SUBJECT;
. Required INFORMATION;
. Delivered INFORMATION;
. ACTIVITIES and DECISIONS.
. Duration (min - max);
. Remarks.

PROCEDURE:

. Activity number: A-n.m;
. Activity name;
. Application area;
. Co-ordinating SUBJECT;.
. Duration (min - max);
. Remarks.

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n, m, l, k = 1, 2, ...

LEVELS OF INFORMATION:

- Group of Information carriers;
- Information carrier;
- Group of Information elements;
- Information element.

GROUP OF INFORMATION CARRIERS:
. Info number: I-Group.k;
. Info name;
. List Information carriers;
. User SUBJECT;
. Remarks.

INFORMATION CARRIER:
. Infonumber: I-n;
. Infoname;
. Type of Information;
. Carrier type;
. Creator SUBJECT;
. User SUBJECT;
. Remarks.

GROUP OF INFORMATION ELEMENTS:
. Info number: I-n.m;
. Info name;
. Creator SUBJECT;
. User SUBJECT;
. Owner SUBJECT;
. Type of Information;
. INFORMATION ELEMENTS: I-n.m.l;
. Remarks.

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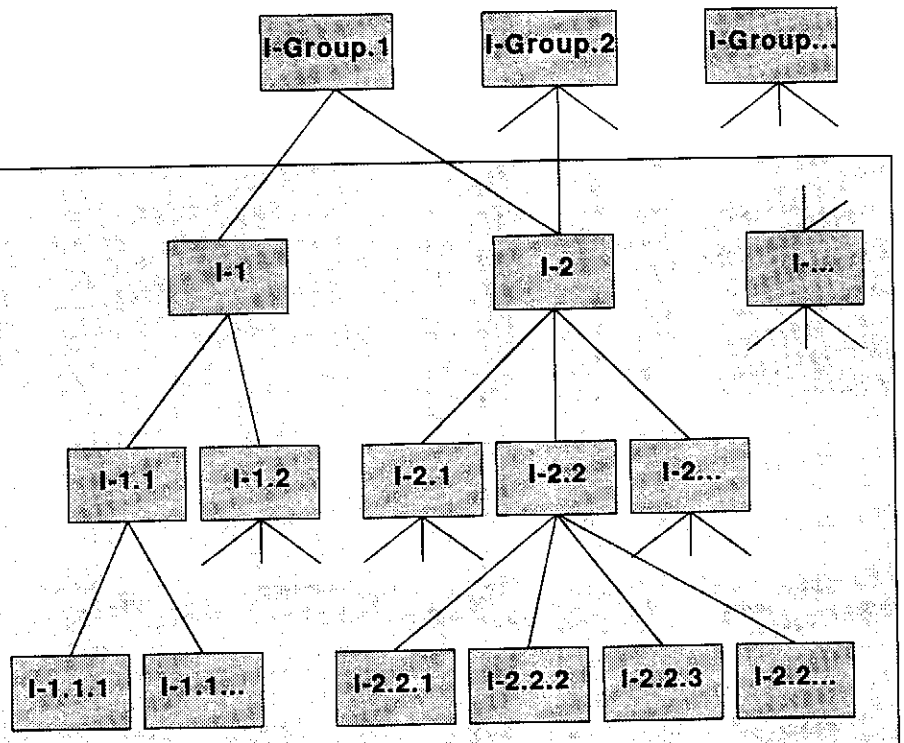
GROUP OF INFORMATION CARRIERS:
Info number: I-Group.k

INFORMATION CARRIER:
Info number: I-n

GROUP OF INFORMATION ELEMENTS:
Info number: I-n.m

INFORMATION ELEMENT:
Info number: I-n.m.l



Hierarchical part of the structure.

n = 1, 2, ...
m = 1, 2, ...
l = 1, 2, ...
k = 1, 2, ...

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GROUP OF INFORMATION CARRIERS:
Info number: I-Group.k

Examples:
I-Group.1 Production folder.
I-Group.2 Technical Product Documentation.
I-Group...

n = 1, 2, ...
m = 1, 2, ...
i = 1, 2, ...
k = 1, 2, ...

INFORMATION CARRIER:
Info number: I-n

Examples:
I-1 Development order.
I-2 Project schedule.
I-3 ...

GROUP OF INFORMATION ELEMENTS:
Info number: I-n.m

Examples:
I-1.1 Order to build prototypes.
I-1.2 Order to test prototypes.
I-1.3 ...

INFORMATION ELEMENT:
Info number: I-n.m.I

Examples:
I-1.1.1 Supply date (data type: date)
I-1.1.2 Available budget (data type: amount of money).
I-1.1.3 ...

Hierarchical part of the structure.

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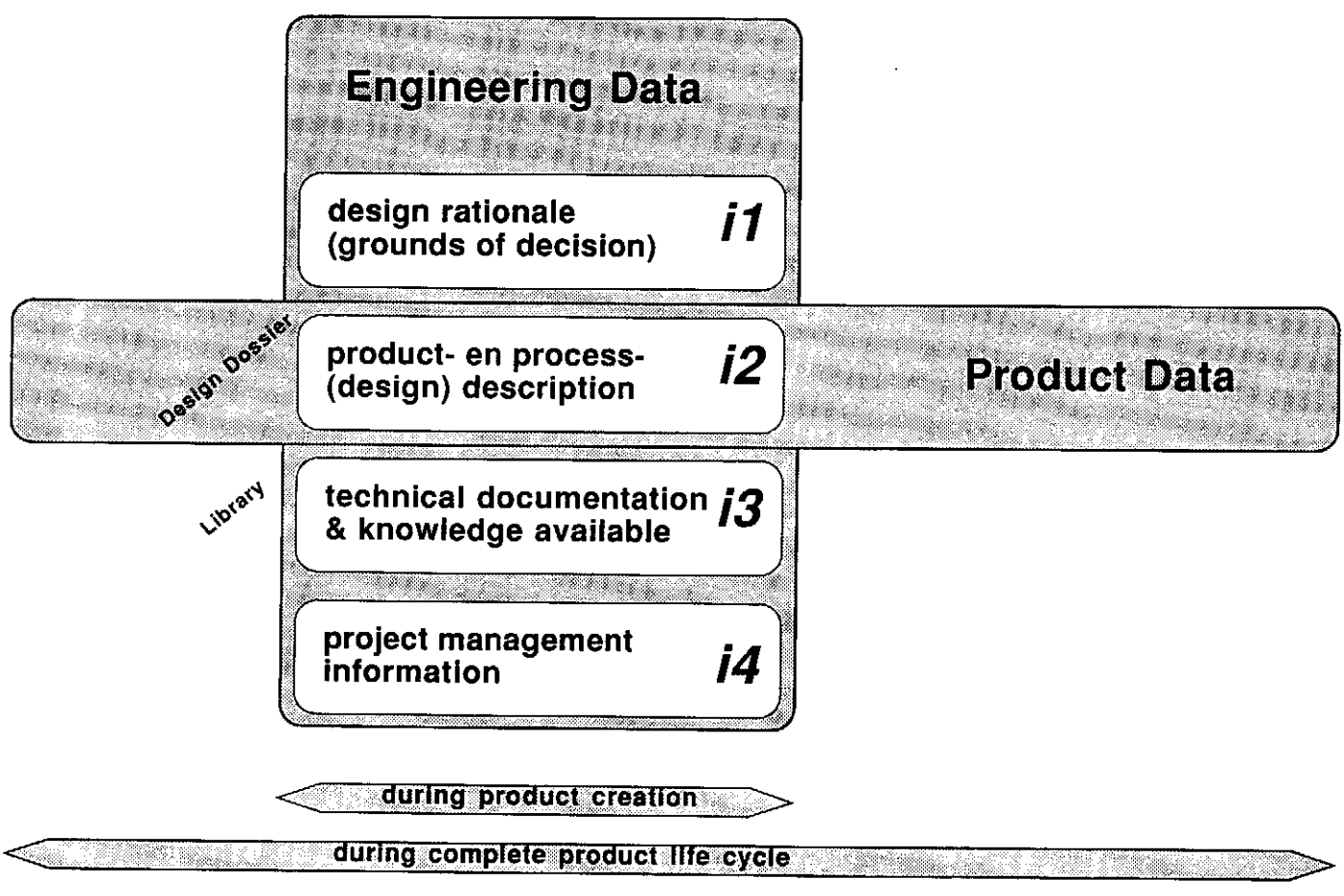


Vroom, June 1994.

LEVELS OF SUBJECT:

- ☒ *Company (1);*
- ☐ *Line & staff department;*
- ☒ *Subdepartment;*
- ☒ *Man/machine;*
- ☐ *Role (no attributes).*

COMPANY/BUSINESS UNIT:
. Subject number: S-0;
. Subject name;
. Remarks.

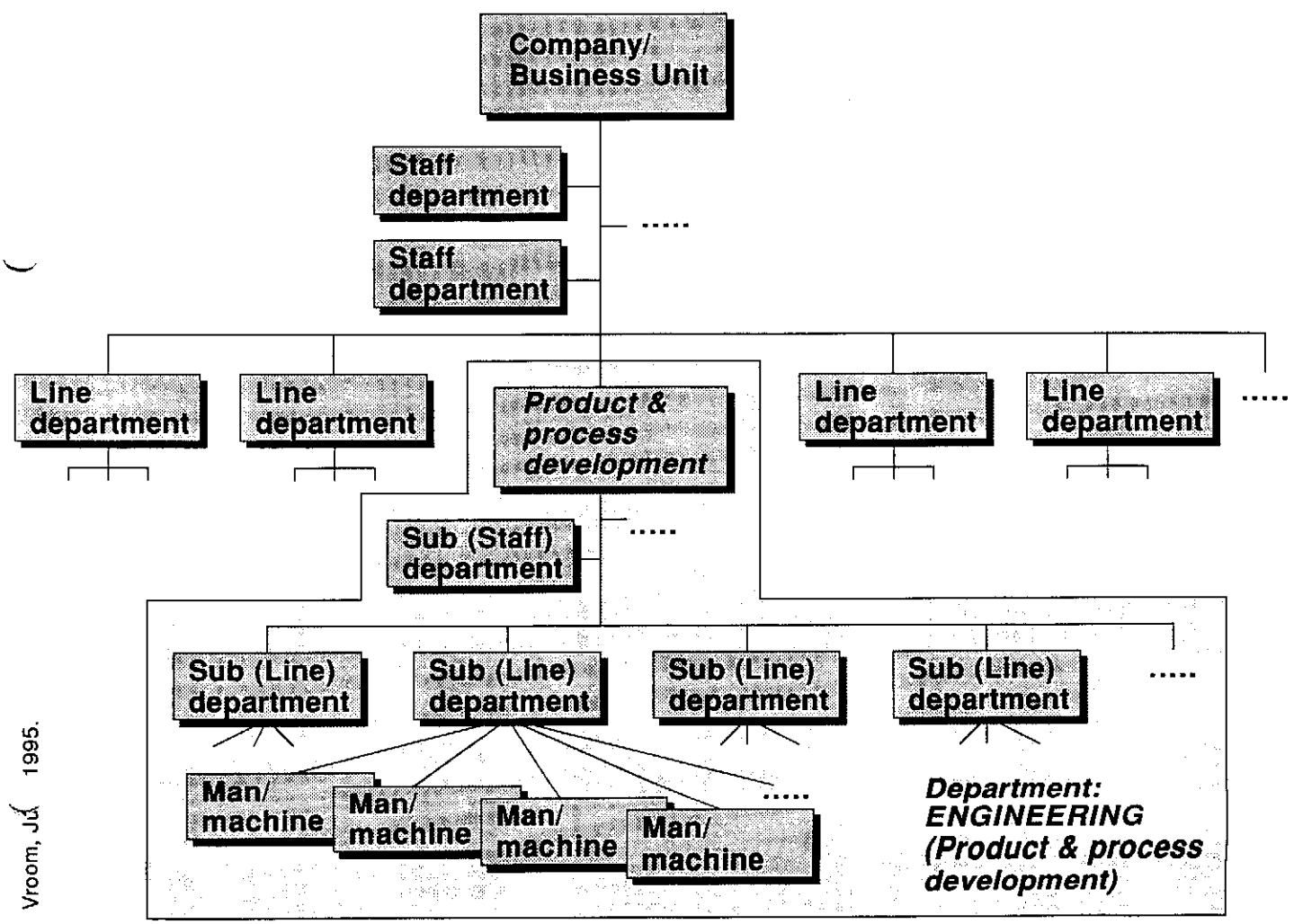
LINE & STAFF DEPARTMENT:
. Subject number: S-n;
. Subject name;
. Type;
. Knowledge and skills required;
. Remarks.

SUBDEPARTMENT:
. Subject number: S-n.m;
. Subject name;
. Type;
. Knowledge and skills required;
. Remarks.

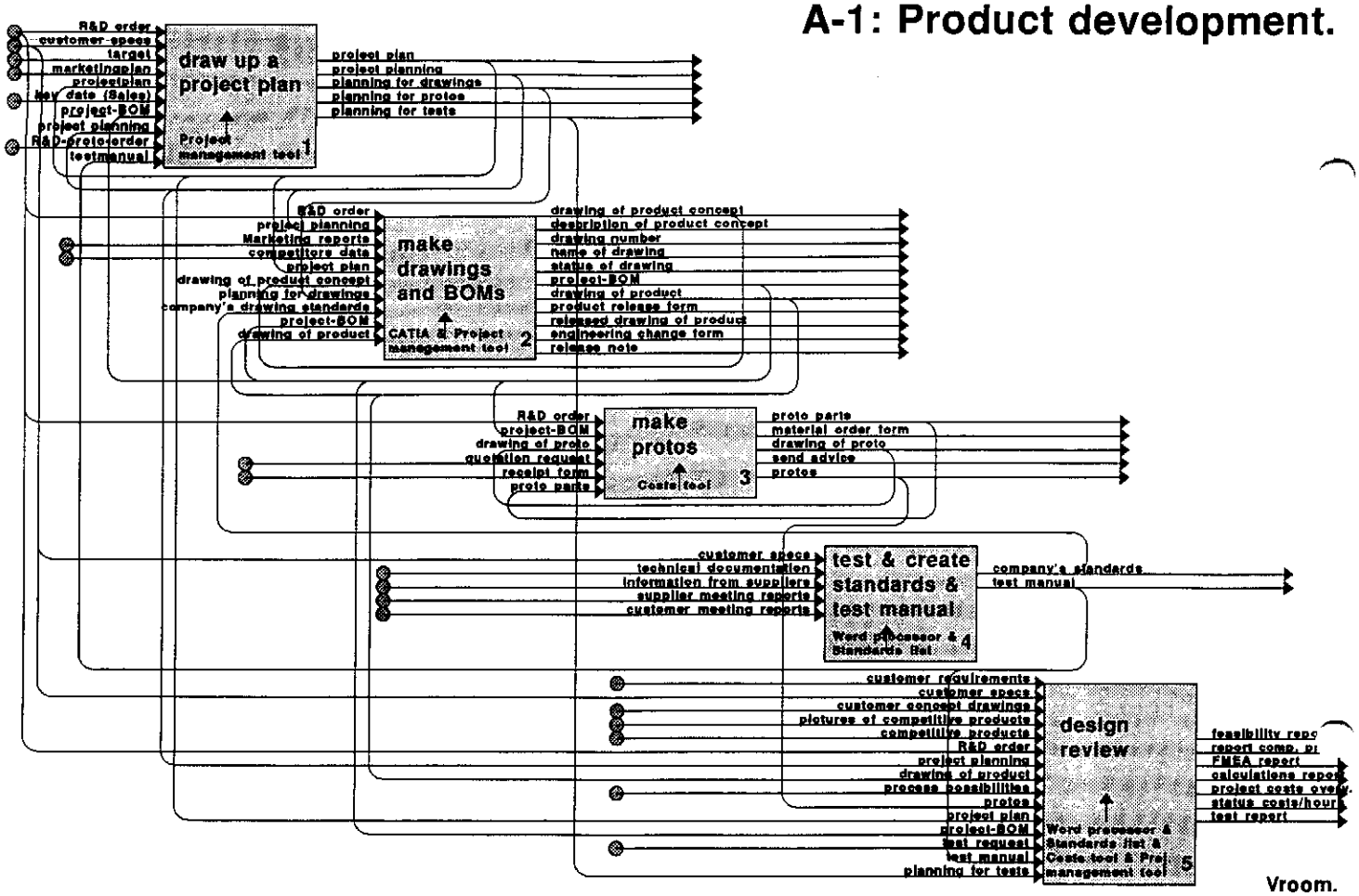
MAN/MACHINE:
. Subject number: S-n.m.l;
. Subject name;
. Knowledge and skills required;
. Roles: S-n.m.l.k.
. Remarks.

n = 0, 1, 2, ...
m = 0, 1, 2, ...
l = 1, 2, ...
k = 1, 2, ...

Vroom, June 1995.

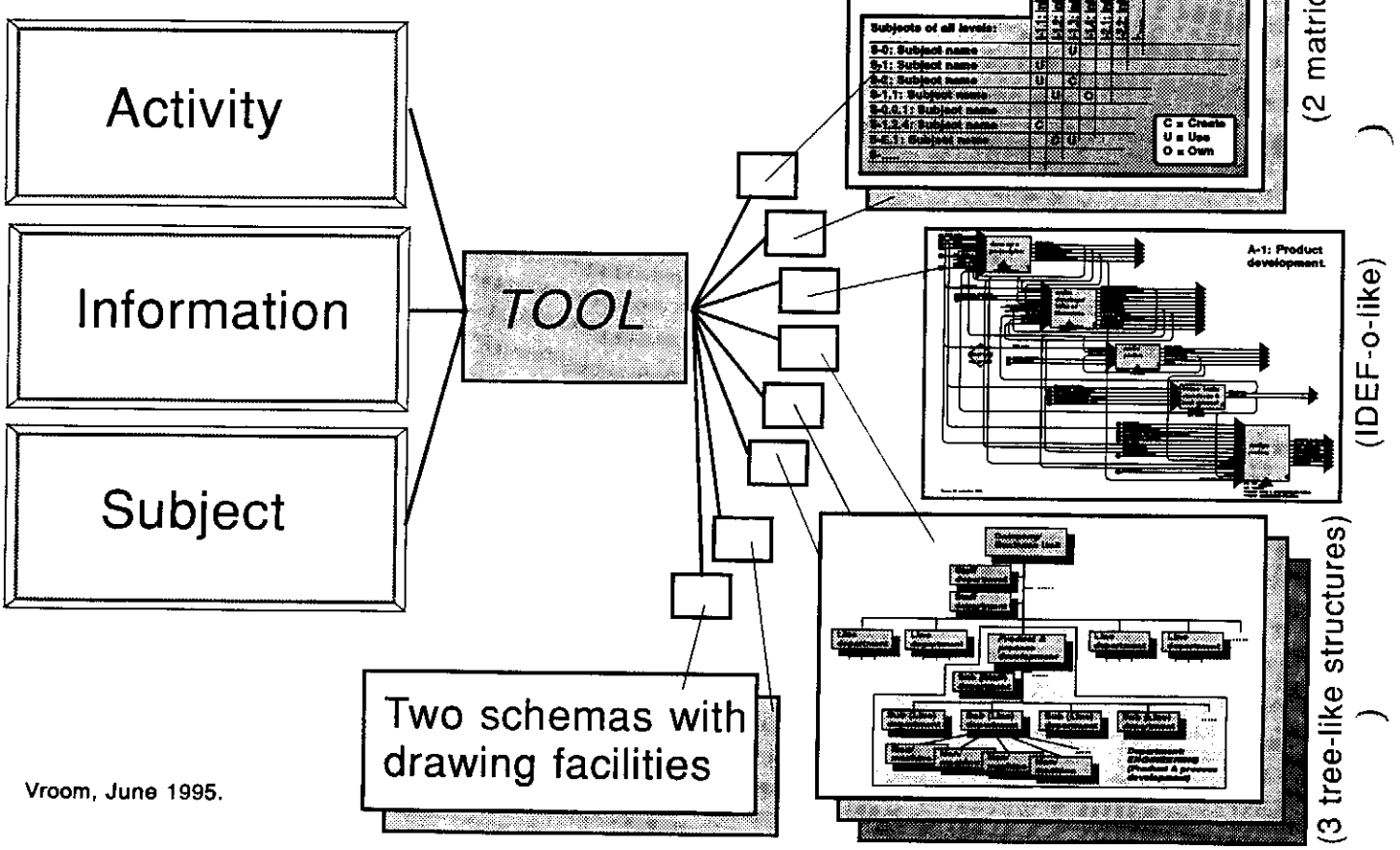


A-1: Product development.

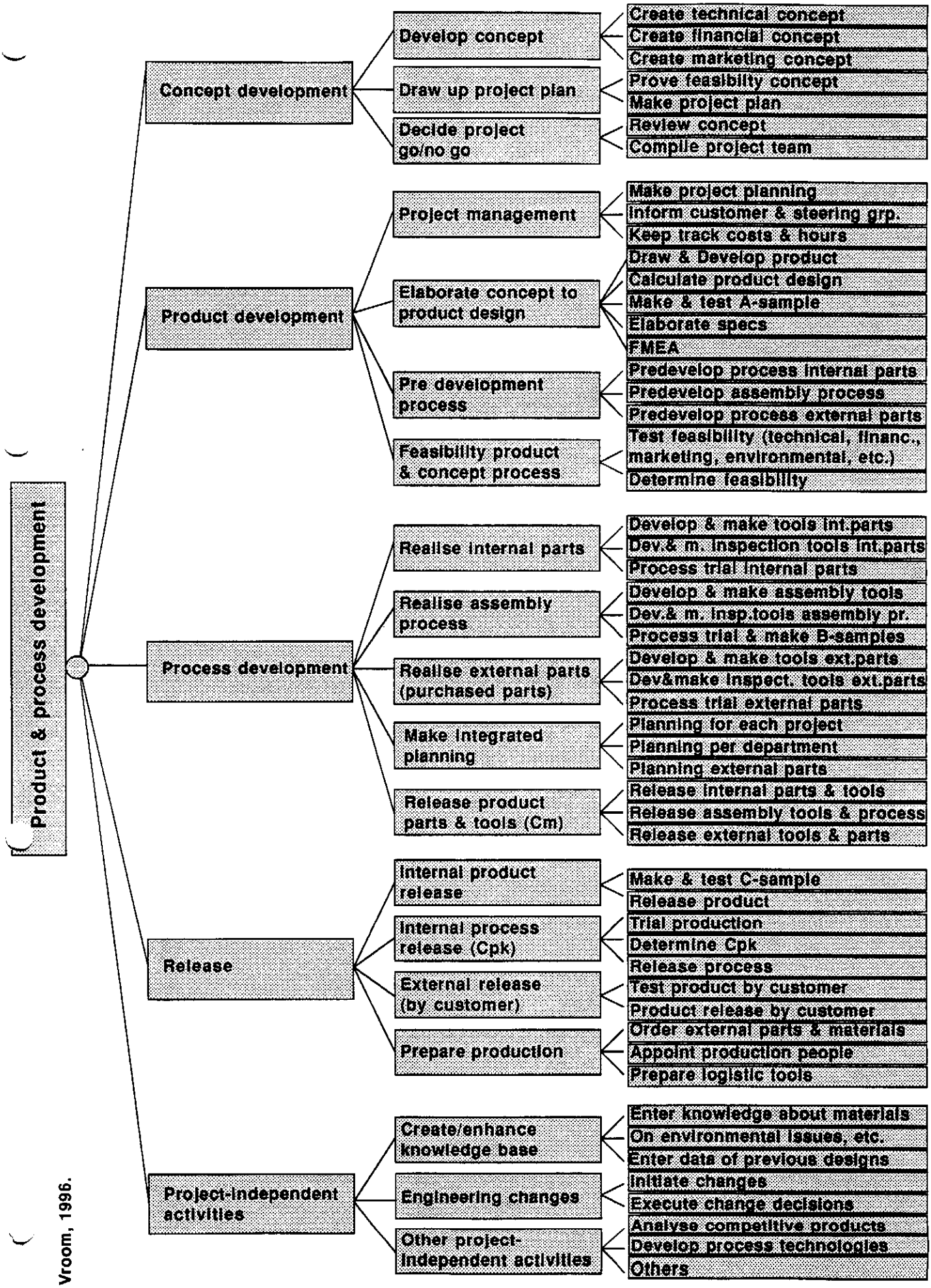


Six schemas automatically produced

Three Objects



Vroom, June 1995.


Product & process development
Concept development
Develop concept
Create technical concept
Create financial concept
Create marketing concept
Draw up project plan
Prove feasibility concept
Make project plan
Decide project go/no go
Review concept
Compile project team
Product development
Project management
Make project planning
Inform customer & steering grp.
Keep track costs & hours
Elaborate concept to product design
Draw & Develop product
Calculate product design
Make & test A-sample
Elaborate specs
FMEA
Pre development process
Predevelop process internal parts
Predevelop assembly process
Predevelop process external parts
Feasibility product & concept process
Test feasibility (technical, financ., marketing, environmental, etc.)
Determine feasibility
Process development
Realise internal parts
Develop & make tools int.parts
Dev.& m. inspection tools int.parts
Process trial internal parts
Realise assembly process
Develop & make assembly tools
Dev.& m. insp.tools assembly pr.
Process trial & make B-samples
Realise external parts (purchased parts)
Develop & make tools ext.parts
Dev&make inspect. tools ext.parts
Process trial external parts
Make integrated planning
Planning for each project
Planning per department
Planning external parts
Release product parts & tools (Cm)
Release internal parts & tools
Release assembly tools & process
Release external tools & parts
Release
Internal product release
Make & test C-sample
Release product
Internal process release (Cpk)
Trial production
Determine Cpk
Release process
External release (by customer)
Test product by customer
Product release by customer
Prepare production
Order external parts & materials
Appoint production people
Prepare logistic tools
Project-independent activities
Create/enhance knowledge base
Enter knowledge about materials
On environmental issues, etc.
Enter data of previous designs
Engineering changes
Initiate changes
Execute change decisions
Other project-independent activities
Analyse competitive products
Develop process technologies
Others

Vroom, 1996.

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Product & Engineering data

Type *i1*: Design rationale

I-01 Feasibility report;
I-02 Customer meeting report;
I-03 Price request;
I-04 Supplier meeting report;
I-05 Calculations product design;
I-06 Cost price calculation report;
I-07 Project-specific info competitive products;
I-08 FMEA report;
I-09 DFA report;
I-10 Test report;
I-11 Tool inspection report;
I-12 Product measuring report;
I-13 Capability study (0-series).

Type *i2a*: Product & process descriptions

I-14 Development order;
I-15 Target list;
I-16 Customer requirements;
I-17 Product concept drawing;
I-18 Product concept description;
I-19 Parts list;
. during development;
. during production;
I-20 Pre calculation;
I-21 Product drawing:
. drawing during development;
. proto drawing;
. drawing released;
I-22 Test manual
I-23 Cost price report;
I-24 Prototype parts (physical);
I-25 Prototype (physical);
I-26 Forwarding advice prototype;
I-27 General technical data about designs;
I-28 Production process design:
. Concept production process;
. Actual Toolings State;
I-29 Flow chart of production process;
I-30 Tool drawing;
I-31 Tool (physical);
I-32 Sample (physical);
I-33 I.S.R. part;
I-34 I.S.R. end product;
I-35 Quality plan;
I-36 Inspection-instruction sheet;
I-37 Inspection tool (physical);
I-38 Work instructions;
I-39 Packing instructions;
I-40 Product part (physical).

Type *i2b*:

I-41 Design change form;
I-42 Drawing change form;
I-43 Feed back sheet production.

Type *i3*: Library information

I-44 Marketing report;
I-45 Competitive products comparison report;
I-46 Competitive products (physical);
I-47 Information on competitive products;
I-48 General company standards;
I-49 General company specs for a product type;
I-50 Customer specification;
I-51 General Technical documentation;
I-52 Suppliers product information;
I-53 Process potentialities (knowledge available);
I-54 Machine data;
I-55 Tool standards.

Type *i4*: Project management information

I-56 Project plan;
I-57 Project planning;
I-58 Part requirements related to milestones;
I-59 Drawings planning;
I-60 Prototypes planning;
I-61 Tests planning;
I-62 Product design release document;
I-63 Drawing release form;
I-64 Take delivery form;
I-65 Materials order form;
I-66 Marketing strategies;
I-67 Survey of project costs & hours spent;
I-68 Tools survey;
. Tools proposal list;
. Tools work order;
I-69 Change processing form;
I-70 Form to put out to contract;
. Engineering request;
. Contract;
I-71 Process release document.