A Logic to Handle, Define and Process Item Characteristics in ERP

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***Abstract*—*The proper definition and structure of item classifications, item attributes, and variants are for companies challengeing. Especially if such structures should be processed in ERP system. So handling of static and dynamic characteristics in ERP processes and master data like static or dynamic Bill of Materials (BOM) and static or dynamic workplans will be considered. In this paper an approach is shown which was implemented in a ERP system.*

Keywords—bill of material, configuration, item attributes, item characteristics, item hierarchy, static and dynamic attributes, static and dynamic master data, work plan, variants

1. INTRODUCTION

Characteristic values of items are a very important source of information in manufacturing companies, especially in variant production, and deliver a complete definition including properties, characteristics and attributes of an item. Variant means that the characteristics of the item can take different values per variant. The characteristics with their different values exist initially according to the master data of the Enterprise Resource planning (ERP) and Computer Aided Design (CAD) / Product Lifecycle Management (PLM) programs up to the business processes [1, 2, 3].

Due to a hierarchical definition of attribute lists, such characteristics and properties can be registered in a user-friendly manner and faulty insertions can be avoided.

The number of characteristics queried and the values/attributes that are available, depend on previous definitions. Additionally, conditions and rules should be determined for the characteristics, that means, that these conditions must be fulfilled, so that the certain characteristic can be addressed. It should also be possible to link a characteristic / characteristic value to a specific schema and to define a specific rule. This means that characteristics can be calculated automatically under a defined condition or can always have a constant value. Thus, the influence of the user is limited to the necessary minimum – incorrect combinations of characteristics are not possible.

Employees Often must deal with these characteristics in day-to-day business without knowing who benefits from this knowledge and how far it can be transferred into valuable knowledge or rules. The task is to analyze, identify and classify the influences and possibilities of the objectives that want to be achieved.

Questions listed below should help to formalize this knowledge:

- What are the process definitions?
- Are there dependencies and workflows?
- Are there rules that always result due to certain combinations of characteristics?
- How is the company language defined?
- Are there standardized multilingual terms?
- What kind of products do we manufacture, and which ones do we want to manufacture, promote or not offer at all?
- Knowledge about these products?

2. METHODOLOGY/ANALYSIS

A. *Recognition of the characteristics*

The characteristics and their characteristic values must be defined clearly. What characteristics are neutrally existent and what characteristic values describe the state/character of these characteristics? These are attributes.

With a design-approach, handling of variants including properties, characteristics and attributes combined with ERP-logic will be presented. Moreover, the following concept shows additional integration to an item-configurator including all dependent ERP-processes and ERP-logic.

B. *Dependencies between characteristics and characteristic values*

When a business process, a product, an item, or a checklist is analyzed, dependencies, inclusion and exclusion rules, values and logics must be described.

These analyzed items and the logic behind them must be designed in a repeatable way. Dependencies between characteristics and characteristic values must be handled in the same way. Beside to a configurator, the characteristics can be used in many domains within the ERP system. These domains are described in the following chapters.

3. APPROACH

The following main topics are analyzed for the entire characteristic system are provided with tools and methods:

A. *Classification of Item- Part Families*

Within the analysis phase as main approach the DIN 4000/1 [4] was chosen.

In this hierarchy, the following conditions must be considered to remain the whole system functional.

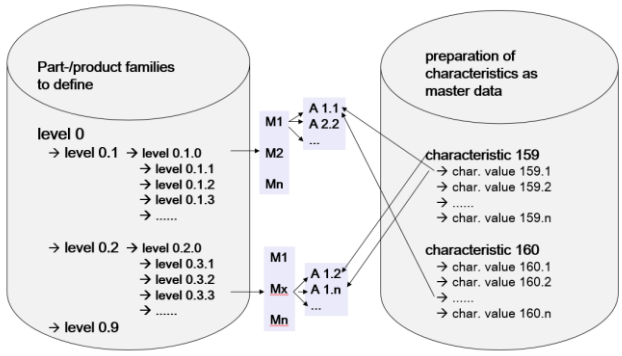

Fig. 1. Item families and characteristic assignment

Instead of designing a single-step list of all product part families, this method facilitates the design of item-structures hierarchically. This works with generic groups. Afterwards these groups are categorized into subgroups and so on. This creates a tree structure of the item- families. E.g.: Top level → machine elements, 2nd level: mounting elements → 3rd level: screws, etc.

To include any characteristics or characteristic values in the product item family names and subfamilies will not work proper and leads to the risk, that the whole system will not be functional anymore. These characteristics must be abstracted from the labels and maintained as separate related tables. For example, the 4th plane with hexagonal screw, lens screw, cylinder head screw would be wrong. These are characteristic values of the characteristic 'screw designation' (see Annex, Fig. 6 and 7).

The following questions should be used to define item-families:

Question form	**Result**	**Allowed?**
What?	What kind of characteristics are describing the families? → Product Part families	Yes
What?	What does the part family consist of? → BOM	No
How?	How is such a part/product structured? → Work Schedule	No
Where?	Where are these parts used?	No

Fig. 2. Permitted question forms in the determination of the part families

If these questions are not considered of the classification, bills of materials (BOM) and work plans cannot be generated automatically an in a generic way by the ERP system.

An item family is allowed once in the entire classification to keep the system stable.

Partial enormization	**Use/Benefits**
Masterdata	Part/Item Classification
	Find similar parts over characteristic values. Multilingual characteristic values facilitate the registration of foreign-language article names
	Uniform label templates for articles also in multilingualism.
	Identify characteristic values
	Uniform interface based on common or preferred characteristics
	Uniform interface based on common orpreferred characteristics → one-time maintenance of the characteristics and characteristics
Item Lists	Uniform interface based on common orpreferred characteristics → one-time maintenance of the characteristics and characteristics
CAD/PLM Interfaces	Uniform interface based on common orpreferred characteristics → one-time maintenance of the characteristics and characteristics

Fig. 3. Areas of influence of partial enormization

B. Product configurator

A product has several characteristics with many characteristic values. These characteristics and manifestations later exclude or include certain characteristics or their manifestations. In order to be able to map these logics, the characteristics and their characteristic values must be presented logically based with decision tables within the ERP system. This creates a network with many nodes and dependencies.

The characteristic contents can also be calculated by formulas according to certain conditions, that apply to the selection and can then be passed into other characteristic values.

Characteristic types

Characteristic-Types, which are also suitable for a configurator, should have the following attributes:

- Static features: Numeric, alphanumeric, date
- Dynamic features: Freely definable fields with logic

In the case of numerical and alphanumeric characteristics, nothing special can be noted. In contrast, the date characteristic offers enormous flexibility in the ERP packages. The characteristics of the type Date can be used, as shown in this example: the release system of the drawings/ BOMs in the change system can be managed very elegantly.

The characteristics, whose content can receive a free select- statement are dynamic features that can obtain information from the database at run time.

Example:

- The process of terminating a BOM listed item can generates a demand to a specific datetime. If no stock is available, an alternative item will automatically be terminated.
- An order operation could be determined and automatically resolved using a select statement with/without capacity.

An extension of the possibility is also given by the commands such as insert, update or delete or with functions or procedures.

Variant master BOMs

The variant BOMs are mapped according to the same logic with the characteristics and their conditions. The conditions

can be registered using the decision tables with the possibility of the associated formula. This is where the if/then logic prevails.

In order to maintain the variant master BOMs more easily, the possibility of pseudo-assemblies should not be forgotten. These are used to structure BOMs. In addition, the maintenance effort of the variant master BOMs is reduced. In the terminated form of the order BOMs, these pseudo-assemblies disappear, and their components are automatically dragged up a BOM level. Another advantage of these logical pseudo-assemblies is given in the variant work plans.

The calculation possibilities in the variant master BOMs are extensive. An important function is to handle "semi-finished" items. For m/m2 semi-finished items, the number, length, or width of the BOM lines can be calculated based on the characteristics from the configurator. Functionality also allows the field contents to be determined and filled in based on the characteristics.

Variant work plans

Such work plans are maintained in the same way as the variant master BOMs. This is where cost centers and suppliers are eligible for the subcontracting operations. Characteristics such as order quantity, customer, length, width, color, etc. are relevant for the ERP system to decide in a generic way if pseudo-assemblies will be produced inhouse or subcontracted to a supplier.

Variant text standardizations

In principle, standardized text must be assigned to the items and item families in a generic way. The standardized text should contain placeholders. These text can so be generated dynamically by the characteristic values in business processes like customer proposals or customer orders.

So standardized text can be automatically dissolved via decision tables according to the same principles as mentioned before.

4. RESULTS

Following characteristics are available within in the ERP package across all relevant business processes and master data.:

Product standardization/ configurator	**Use/Benefits**
Masterdata	Product/article text standardizations
	Automatic parts system based on the configurator
	Variant based BOMs
	Variant work plans
	Formula and calculations for other characteristics and BOMs, operation fields (such as time, etc.)
Project planning/sales	Surcharge pricing on characteristic values
	Resolution in project or offer BOM
	Automatic text generation in quotation/order
Calculation	Estimate of a project/offer structure
Purchasing	Request/order via a variant part number with variable characteristic characteristics
Technical order processing	Resolution into an order BOM and an order route
DMS	Characteristics of the images and documents
Workflow management	Intervention and rules of business processes
CAD/PLM Interface	Feature exchange
Business Intelligence (BI)	Evaluations

Fig. 4. Areas of influence of partial enormization

Modules	**Use/Benefits**
Masterdata	Codings in the item master data and different master data
	Various codings in item master data or BOM and routings such as valves, lubricating parts, spare parts, loose parts, etc. for the function BOMs
Attesting	The characteristics for acceptance type, test basis, etc.
Supplier evaluation	Dynamic and static features
CRM/Service	Checklist creation, service logs
Test plans	Inspection
Dynamic Table Field Extensions [5]	Dynamic and static features
SIK Checklists [5]	Calibration reports, test protolls, etc.

Fig. 5. Use of features without configurator

5. FUTURE WORK

- Recognition of the manifestations via artificial intelligence (AI).
- Automatic suggestions for error/problem solving.
- Search access via any characteristic expression in the network of the characteristics taking into account the next possible characteristic combinations.
- Interface-Connection to CAD models and feature exchange between the two systems.

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7. ANNEX

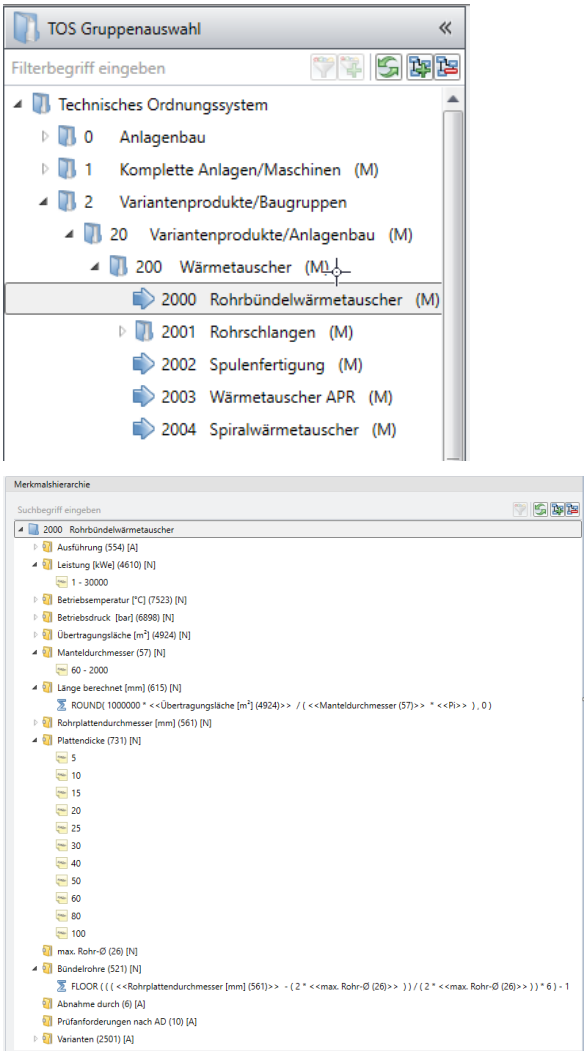

Fig. 6. Example -Heat exchanger

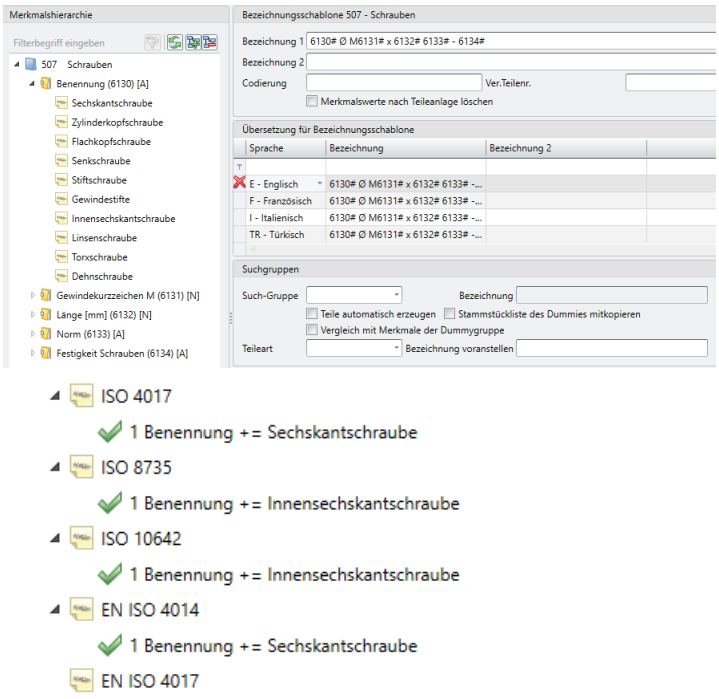

Fig. 7. Example-Screws