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PSLX Engineering Specification

PSLX Domain Objects

PSLX-03

Version 0.2

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2003.6.2		0.1	Translate to English
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18 <Note>

19 PLSX Consortium Japan and the members do not take on the responsibility
 20 for any losses caused by using this specification and the contents
 21 of this specification.

22

1 Introduction

1.1. Purpose of This Specification

This specification defines the universal structure of object model required for implementing APS as a concrete system in the individual manufacturing enterprises. The object models prescribed in this specification are the schemata that individual models are abstracted to be applicable to all types and forms of enterprise. This specification shows how to make each system the data structure based on PSLX.

When designing the database in individual manufacturing enterprise, the number of person hours for development can be decreased sharply by using the object model prescribed in this specification. When the independent systems in the enterprise or between enterprises decide the data structure based on the domain objects together, the data can be linked between the systems very flexibly.

1.2. Intended Readers

The intended readers of PSLX Engineering Specification are as below.

Manager in charge of IT of manufacturing enterprise, Engineering staff at IT section of manufacturing enterprise, Consultant in IT strategy of manufacturing enterprise, Consultant in production control, Manager of SI enterprise, Engineering staff of SI enterprise, Manager of software package vendor, Engineering staff of software package vendor, Student in manufacturing management

1.3. Structure of Specification

The structure of this specification is as below. Chapter 2 explains the basic way of thinking for modeling or how to use the domain objects. Chapter 3 simply explains the outline of domain objects so as to see the entire structure. In from Chapter 4 to Chapter 10, the meaning and the way of using each class of the domain objects are explained

1 in detail. The specifications of each class are described as the
2 referenece information in the appendix.

3 **1.4. Policy on Copying Specification**

4 PSLX Consortium Japan owns copyright on this specification. However
5 it is free to copy this specification and distribute the copies. It
6 is also free to translate the contents of this specification into
7 foreign languages except English. But it is prohibited to modiy the
8 contents of this specification without the permission of PSLX
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11 (<http://www.pslx.org>) of the applicable item on the WWW site of PSLX
12 Consortium Japan preserving this specification.

13

1 **2. Domain Objects**

2 **2.1. Roles of Domain Objects**

3 The domain object is the aggregate of data and procedures that is
4 specific to the APS domain (problem area). However the defined domain
5 object differs from APS agent and is always passive. In short, the
6 domain object does not make a request to other objects on the outside.

7 PSLX Domain Objects are used for designing a data model when APS agents
8 in Part 2 “APS Agent Model” store the contents of message exchanged
9 each other and the information inside.

10 **2.2. Basic Rules for Modeling**

11 PSLX takes the basic rules as below for modeling the various targets
12 related with the plan or scheduling problems of manufacturing
13 enterprise.

14 ●Classes and objects

15 The targets to be modeled in this section are the objects that exist
16 individually in the production site and can be identified individually,
17 and the classes that are the abstraction of features of goods. This
18 specification, “PSLX Domain Objects” regards these targets of two
19 types as classes on the object-oriented modeling. (The example in
20 each production site corresponds to an object.)

21 ●Modeling mainly items

22 All the goods related with production are expressed as items. All the
23 goods to be produced, to be consumed, to be used in production are
24 abstracted as classes of item.

25 ●State changed by event

26 The state changes basically and scatteredly. In short, one state
27 changes to the next state when any event occurs. Conversely, unless
28 the event occurs, the state does not change.

1 When some features possessed by an item differ according to the time,
2 some state objects at every time express them.

3 ●How to express flow

4 When the concrete goods (e.g. raw material) individually existing in
5 the production site change to the different goods (e.g. product) by
6 any operation, both goods are expressed as completely different goods.

7 In this case, the objects indicating the goods to be consumed and to
8 be produced exist permanently and only the stock level changes before
9 and after operating.

10 ●Model as ontology

11 If the target model is abstracted too extremely for dealing with
12 various types of production, after all nothing is expressed.
13 Therefore in PSLX Domain Objects, the most important evaluation is
14 to divide the classes of object into the best size of building block
15 to be used commonly. In short, it is the point that how the
16 complicated and various models can be expressed by fewer objects.

17 **2.3. PSLX Descendant Schema**

18 The content prescribed in this specification is the concept model of
19 the information for APS domain. It is supposed that the shown
20 contents are used according to each feature of the actual information
21 systems after the concrete data structure is derived.

22 The data structure based on PSLX Domain Objects must be able to be
23 derived based on the domain models shown in this specification by any
24 of the following procedures or the combinations of the procedures.
25 In the domain model there must not be the contradiction that the same
26 content is expressed by the different structure in the various classes
27 or attributes as a result of derivation.

28

Procedure	Explanation
Producing subclasses	The subclasses can be defined for class.
Dividing class	The class can be divided into some classes.

Integrating some classes	Two classes can be integrated (including subclasses).
Classing attribute	The attribute can be independent as a class.
Classing relation	The relation can be made a class.
Adding and deleting attribute	The attribute can be added and deleted.
Transferring attribute	The attribute can be transferred or copied between classes.
Adding and deleting relation	The relation between classes can be added and deleted.
Replacing relation	The path of relation between classes can be replaced with shortcut.
Adding constraints	The constraints such as a relation pattern can be added.
Changing class name	The class name can be changed according to the definitions in PSLX Common Dictionary.

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When associating the data items with each other between two PSLX descendant schemata, the items can be associated with each other on PSLX Domain Objects by applying the above operations used for descending each schema in reverse order.

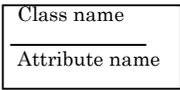
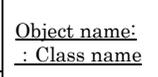
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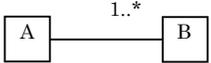
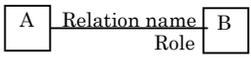
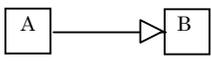
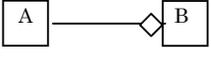
2.4. How to Describe The Model

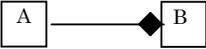
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The class figure of UML is used for describing the domain objects as following. The below table indicates the meaning of each symbol.

8

Model element	Symbol	Explanation
Class		Indicate a class. The class in this specification is a general term for objects and classes in individual manufacturing enterprises.
Object		Indicate an object. The object exists concretely in every

		example.
Number of concurrents	 <pre> classDiagram class A class B A "1..*" -- B </pre>	<p>Indicate the number of concurrents between classes. The example indicates that there are 0 and more objects in Class B for one optional object in Class A. There are 1 (only one), 0..1 (zero or one), * (more than zero) to indicate the number of concurrents. When the symbol of the number of concurrents is omitted, 1 is applicable.</p>
Relation (General)	 <pre> classDiagram class A class B A -- B : Relation name </pre>	<p>Indicate the object relation between classes. "Relation name" meaning the relation can be added. "Role" indicating what role one object has for the other object can be added. The left figure indicates the role of Object B from a viewpoint of Class A. It is necessary to add "Role" when there are some relations between the same classes.</p>
Relation (Generalizing)	 <pre> classDiagram class A class B A -- > B </pre>	<p>Indicate the relation of generalizing or specializing between classes. The left figure indicates that Class A is a subset of Class B. For implementing, Class A inherits and extends the features of Class B.</p>
Relation (Intensive)	 <pre> classDiagram class A class B A -- B </pre>	<p>Indicate the intensive relation between classes. The left figure shows that Class B is the</p>

		unified Class A.
Relation (Composite intension)		Indicate the dependent relation of class adding the intensive relation. The left figure shows that the object in Class A premises the object in the applicable Class B exists.

1 3. Outline of Object Model

2 3.1. Outline of Class

3 The types of the most abstractive classes in this specification, "PSLX
4 Domain Objects" are as below.

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Target information			
	Item	item	Abstraction of goods related with production
	Substancee	substance	Concrete goods related with production
Attribute information			
	Feature	feature	Various features of item
	State	state	Value of feature at one time
Calculation information			
	Way of calculating	subject	How to calculate the required information values
	Calculation value	calculation	Result of calculating values based on the subject
	Basic unit	sd	Basic constant data
Plan information			
	Plan	plan	Plan value specified in every subject
	Constraint relation	constraint	Constraint relation in a numerical value between the plan values
Event information			
	Event	event	Event to change the state
	Individual event	occurrence	Unit showing the concrete occurrence of event
Operation information			
	Operation	operation	How to operate for producing items
	Operation attribute	mode	Operational attribute accompanied with operation

Schedule information			
	Directions	schedule	Executing the operation to deal with an order
	Operation progress	progress	Progress information for schedule
Relation information			
	Time relation	precedence	Time relation between two events
	Operation relation	interval	Relation between two operations and an item
Operation information			
	Action	action	Individual actions of event
	Preconditions	condition	Preconditions for executing action
Production information			
	Production	produce	Relation between operation and the item to be produced
	Lot	lot	Concrete production by schedule
Order information			
	Order	order	Order information from a customer or the outside
	Party	party	Actor information on the outside such as customer
Others			
	Production rule	rule	The necessary rule for operating
	Pegging	pegging	Pegging between some related orders
	Tracking	tracking	Correspondence between lots

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3.2. Relation between classes

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Each class given in the former section has the relation shown in Figure

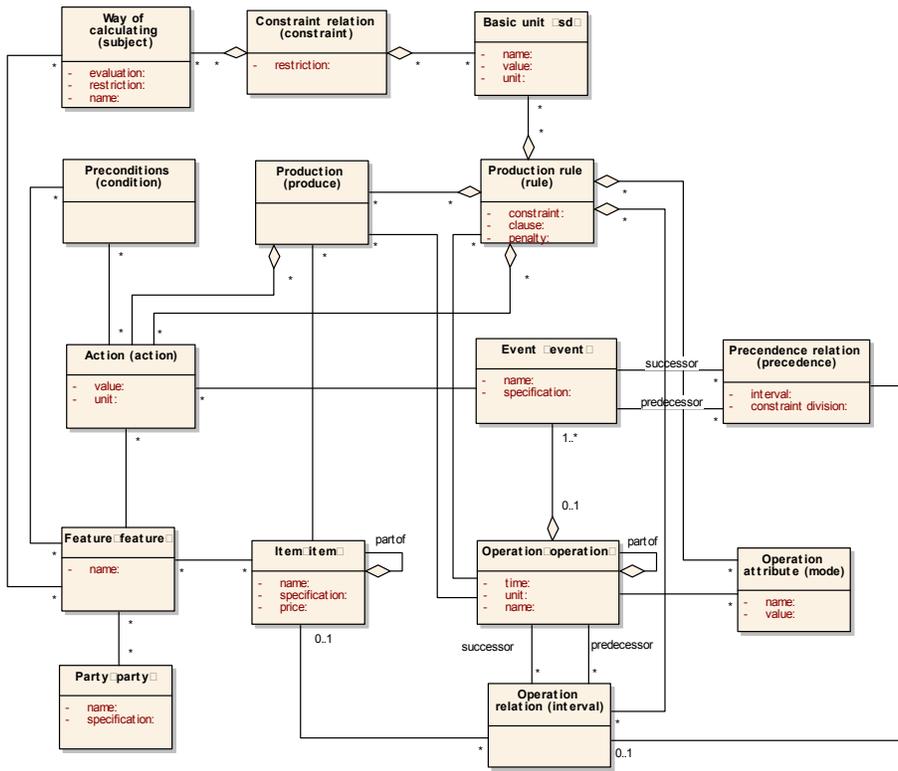
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1, Classes.

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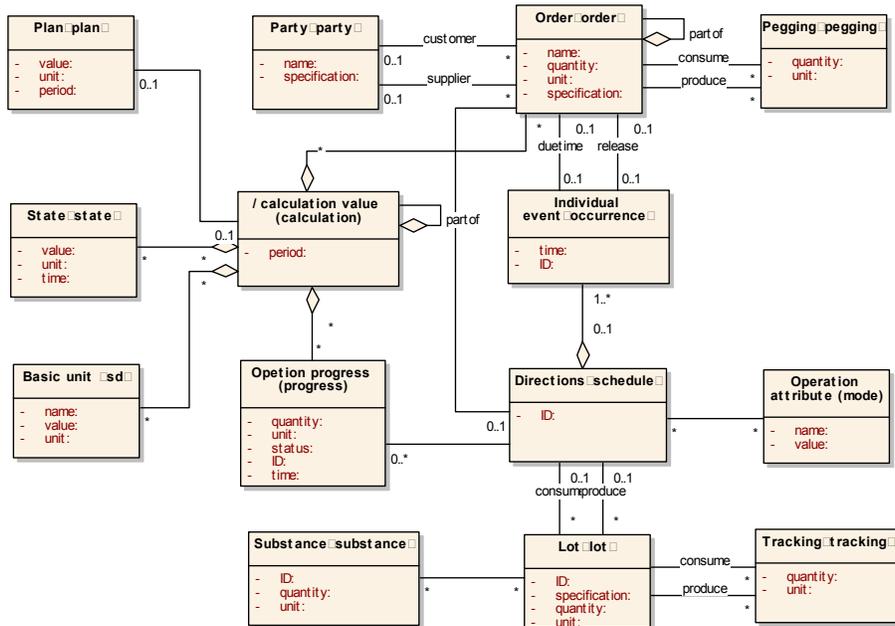
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3.3. Outline of Subclass

The classes shown in the former sections are the highest classes in PSLX Domain Objects. The following subclasses exist for these classes. As the table describes, resource (resource) is a subclass of item and also has its own subclasses (sub-subclasses).

Item	item	
Resource	resource	Item to be used for production
Product	product	Item to be specified by a customer order
Material	material	Item to be provided by a supplier
Work in process	wip	Item in process of producing
Semifinished product	subassy	Item that can be managed as a unit
Resource	resource	
Equipment	equipment	Resource to be directly required for production
Tool	tool	Resource to be required secondary
Labor	labor	Human resource to produce
Workshop	ws	Workstation to execute operation
Work section	shop	Place to execute a chain of operations
Management section	site	Resource unit in the managed range
Lot	lot	
Task	task	Using resource by schedule
Feature	feature	
Stock	stock	Stock information about item
Load	load	Load information about resource
Capacity	capacity	Capacity information about

			item
	Location	location	Location information about item
State		state	
	Amount of stock	stock value	Stock value in every time
	Amount of load	load value	Load value in every time
	Amount of capacity	capacity value	Capacity value in every time
	Content of location	location value	Address of item in every time
Plan		plan	
	Stock plan	stock plan	Plan value on stock
	Load plan	load plan	Plan value on load
	Capacity plan	capacity plan	Plan value on capacity
	Sales plan	sales plan	Plan value on sales
	Purchase plan	purchase plan	Plan value on purchase
Event		event	
	Start	start	Event to start operation
	End	end	Event to end operation
	Suspension	suspend	Event to suspend operation
	Resumption	resume	Event to resume operation
Operation		operation	
	Fabrication	fabrication	Fabricating item
	Transportation	transportation	Changing a location of item
	Storage	storage	Storing item for the fixed period
	Inspection	inspection	Inspecting the quality of item
	Setup	setup	Preparation for production
	Maintenance	maintenance	Maintaining a facility
	Design	design	Operation related with design
	Production	production	Operation related with production
	Sales	sales	Operation related with sales

	Purchase	purchase	Operation related with purchase
Operation relation		interval	
	Switching relation	switch	Relation between two operations and resource
Production		produce	
	Consumption	consume	Relation between operation and the consumed item
	Assignment	assign	Relation between operation and the assigned resource
Order		order	
	Product order	product order	Order specifying a product
	Forecast order	forecast order	Order created inside
	Customer order	customer order	Order from a customer
	Process order	process order	Order corresponding to individual operation
	Outsourcing order	outsourcing	Order for outsourcing
	Purchase order	purchase order	Order for purchaing
	Transportation order	transportation order	Order for transporting and delivering
Party		party	
	Customer	customer	Sender of order
	Supplier	supplier	Receiver of order
Calculation value		calculation	
	Cost	cost	Calculation on cost
	Profit	profit	Calcualtion on profit

1 4. Static Information

2 4.1. Item and Substance

3 **Item (item)** indicates the classes of all the targets related with
4 production. Targets are the goods to be produced, consumed, and used
5 by production. Item is the concept identified by the codes for
6 controlling production, such as “Product P001” or “Parts X002”.

7 Item (item) is the abstract class indicating various targets, while
8 **substance (substance)** is the class indicating the goods existing
9 individually. For an example of substance (substance), “Product No.
10 001-1234 article” produced as a product P001 is given.

11 4.2. Subclasses of Item

12 The subclasses of item (item) are product (product), semifinished
13 product (subassy) , work in process (wip) and material (material) .

14 Product (product) is the item (item) for the order (order) from a
15 customer (customer). The product numbers in the product catalog
16 correspond to products. The semifinished product (subassy) is not
17 usually the item (item) for the order (order) from a customer
18 (customer) but for the forecast order (forecaset order). The unit
19 product produced before accepting an order (order) from a customer
20 (customer) in the BTO (Build to Order)-type production is applicable.

21 Work in process (wip) is the item (item) existing in the process before
22 becoming a product (product) or a semifinished product (subassy).
23 The labor does not usually distinguish it with a code and so the code
24 automatically created by a computer is attached to it. Material
25 (material) is the item (item) before production and for a purchase
26 order (purchase order). Generally the inside code is usually used
27 by being replaced with the product code possessed by a supplier
28 (supplier).

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4.3. Expressing Production Resource

Resource (resource) expresses the items (item) that are used and necessary for production. The typical examples are machines and facilities to be used for producing. This is the subclass of item (item). There are usually many cases where only one substance (substance) exists for each resource (resource). However, when the individual labor like “Kimura” or “Takahashi” exists for the abstract resource (resource) “labor (labor)”, the individual labor is regarded as a substance (substance).

General items (item) are produced (produce) and consumed (consume) by producing. Resource (resource) has the feature that resource (resource) is used (assign) only during producing and returns to the former state again after completing production.

The items (item) made by production such as tool and mold exist in the resources (resource). In such a case, the item (item) becomes an object, which has both the character of item (item) and the character of resource (resource).

4.4. Subclasses of Resource

The subclasses of resource (resource) are equipment (equipment), labor (labor), and tool (tool).

Equipment (equipment) is the machine required for operation (operation) and there are all sorts of equipment, production equipment, storage facility, transfer equipment, and inspection equipment according to the type of operation (operation).

Labor (labor) is the resource indicating a person to operate (operation). The operation needing no labors (labor) exists and also the operation (operation) executed only by a labor (labor) without equipment (equipment) exists.

Tool (tool) is the secondary resource (resource) for equipment (equipment) or labor (labor) to operate (operation). “Mold” corresponds to this tool.

1 Workshop (ws) , work section (shop) , and management section (site)
2 can be also defined as subclasses of resource (resource).

3 Workshop (ws) is the place to operate (operation). The machines and
4 equipment can be considered that they belong to this workshop (ws),
5 and they can be managed by replacing them with this workshop (ws).

6 Work section (shop) is for managing a serial of processes (process)
7 to finish a product (product) with dividing the processes into a large
8 unit such as a processing shop or an assembly shop.

9 Management section (site) indicates the unit for controlling
10 production such as a factory (factory). Usually the minute plans are
11 made inside of the management section (site) and the plans are roughly
12 linked between the management sections (site).

13 **4.5. Expressing Decision Maker**

14 The decision maker outside of APS is expressed as a **party (party)**.

15 The subclasses of party (party) are **customer (customer)** and **supplier**
16 **(supplier)**. These are roles of "party (party)" class. From the
17 viewpoint of APS, the customer (customer) role is the issue origin
18 of order (order) and the supplier (supplier) role is the issue
19 destination of order (order).

20 Suppliers (supplier) are material traders, outside processors and
21 transporters according to requests. These are the roles of party
22 changing according to process.

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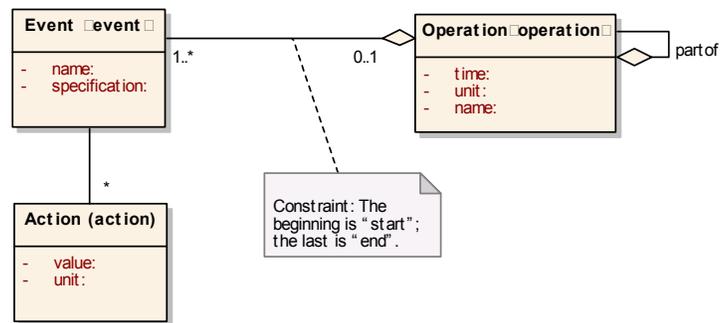
1 5. Information about Operation

2 5.1. Expressing of Event

3 All the various changes in the real world like a production site are
 4 caused by **event (event)**. Event (event) is the action to change the
 5 state (state) of some item (item). Before and after the event (event)
 6 occurs, the state (state) changes uncontinuously.

7 Event (event) may be a part of operation (operation) or exist
 8 independently.

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12 **Figure 2 Relation with Event Class**

13 Event (event) is the abstract class that can be defined beforehand,
 14 while **individual event (occurrence)** is the instance information
 15 showing that such events occur according to each status.

16 If there is “switch valve open” as an event (event), “switch valve open
 17 at 10:12 on April 5, 2003” can be defined as an individual event
 18 (occurrence).

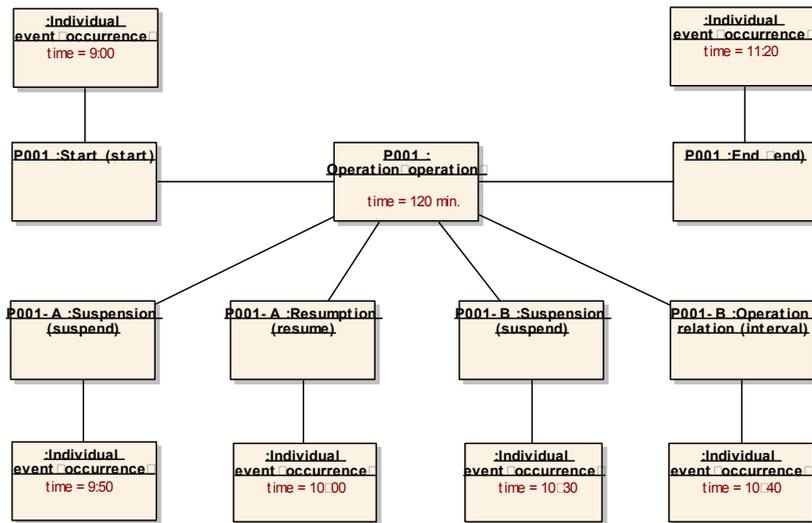
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5.2. Subclasses of Event

Event (event) has the subclasses, **start (start)**, **end (end)**, **suspension (suspend)**, and **resumption (resume)**. These subclasses are part of operation (operation).

Start (start) is the event to start operation (operation). End (end) is the event to end operation (operation). In short, one operation is defined by two events (event), start (start) and end (end).

Suspension (suspend) and resumption (resume) are used when the operation (operation) is not executed temporarily between start (start) and end (end). Suspension (suspend) is the event (event) to stop operation (operation) temporarily and resumption (resume) is the event (event) to restart operation (operation).



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Figure 3 Concrete Example of Event

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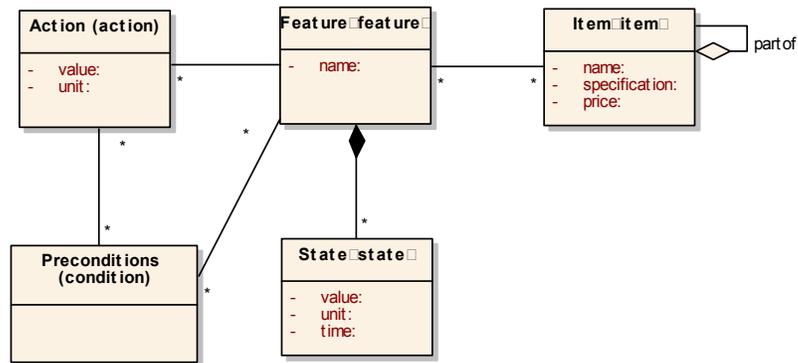
5.3. Action

Action (action) is the class showing the contents of state (state) changed by event (event). Action (action) changes the state (state) of some feature (feature) of the specific item (item).

For instance, action (action) can carry out that “ the number of stock articles of item A is increased by 100” and “the temperature of resource X is risen up by 10 degrees.”

Precondition (condition) is the class showing the necessary conditions when executing action (action). Only in the case where this precondition (condition) is met, action (action) is actually executed.

For example, “if the number of stock articles of item A is lower than the safety stock, 20,” or “if the number of accumulated hours of operating equipment X reaches to 500 hours” can be set up as a precondition (condition).



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Figure 4 Action and Condition

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5.4. Produce · Consume · Assign

In production, production (produce) item (item), consuming (consume) item (item) and assigning (assign) resource (resource) can be expressed by combining actions (action).

1 Generally, **producing (produce)** is the action to increase the number
 2 of produced items (item) in stock (stock) at ending (end) operation
 3 (operation) as the below figure shows. This corresponds to the case
 4 where lot production is executed. In the case of the sequence system
 5 or one-item flow production, the quantity of products in stock (stock)
 6 increases gradually from the start (start) to the end (end) of
 7 operation (operation). In such a case, action (action) alters the
 8 changed value of stock, not the stock value.

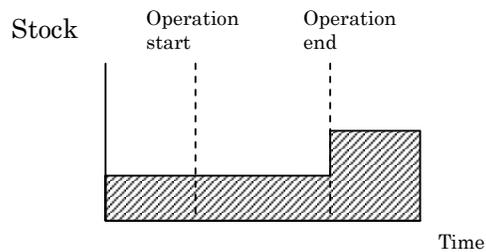
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Figure 5 Action Pattern of Production (produce)

15 **Consumption (consume)** is generally the action to decrease the number
 16 of the required items (item) in stock (stock) at starting (start)
 17 operation (operation) as the below figure shows. Just like the case
 18 of production, the amount of stock (stock value) may continuously
 19 decrease such as a sequence system or one-item flow production.

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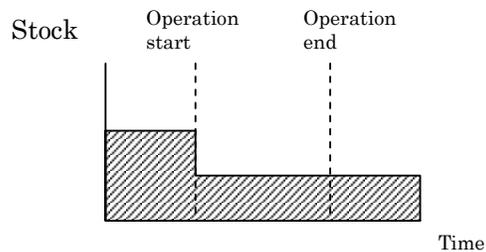
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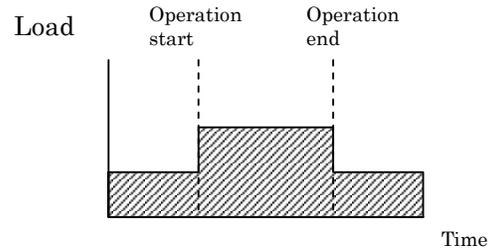


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Figure 6 Action Pattern of Consumption (consume)

27 **Assignment (assign)** is the action to increase the load (load) of
 28 resource (resource) to be used during operation (operation) and to

1 restore the state at ending operation. When executing scheduling, the
2 sum of loads (load) calculated in such a way must not go over the
3 capacity (capacity) of resource (resource).

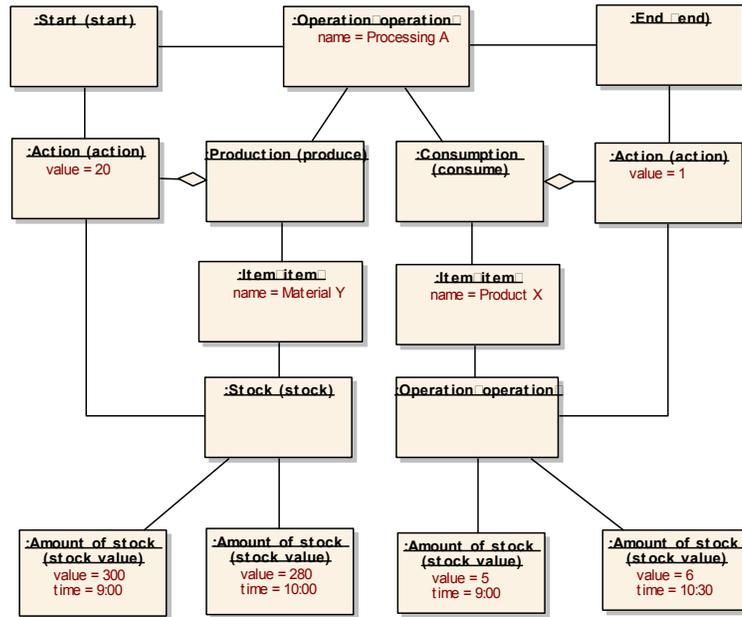


9 **Figure 7 Action Pattern of Assignment (assign)**

10 The following examples are the concrete relations between operation
11 (operation), event (event), action (action), item (item) and feature
12 (feature). The following example shows that the quantity of
13 materials in stock (stock value) is decreased at starting and the
14 quantity of products in stock (stock value) is increased at ending.
15 Stock (stock) is a subclass of feature (feature). Executing this
16 action newly produces the amount of stock (stock value), subclass of
17 state (state).

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Figure 8 Relation between Production (produce) • Consumption (consume) and Action (action)

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5.5. Operation Specific Information

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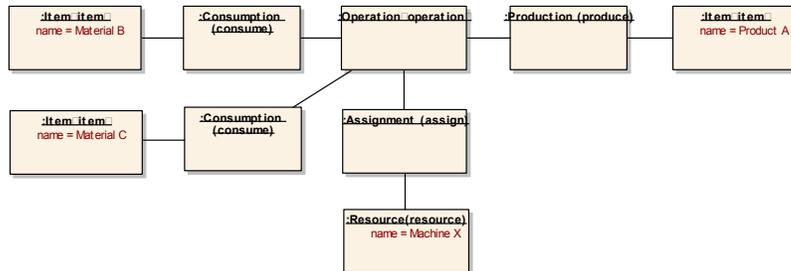
Operation (operation) expresses the feature according to the relation with classes such as production (produce), consumption (consume) and assignment (assign). For example, Operation 001 to produce Product A from Material B and Material C using Machine X can be shown as below.

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Figure 9 Relation between Operation and Item (Resource)

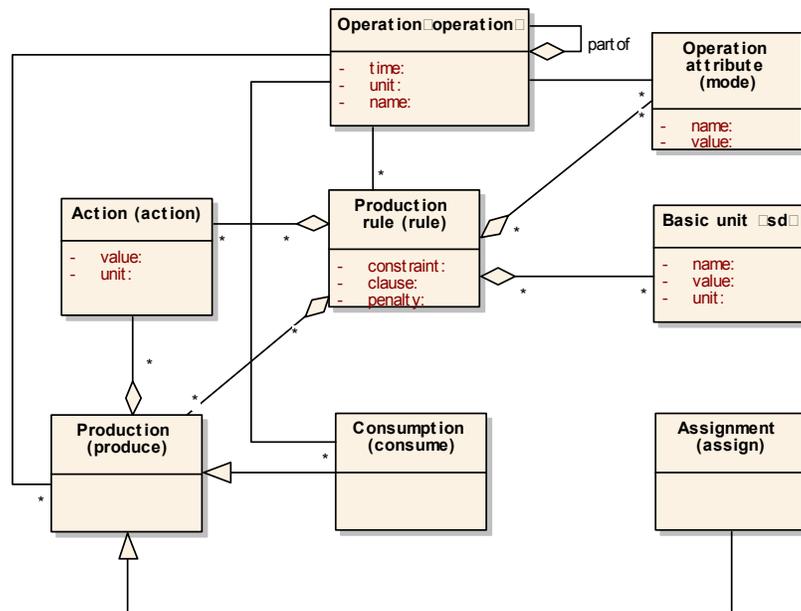
1 The relation between operation (operation) and these classes concerned
 2 with action (action) is the complicated combination, for example the
 3 case where some candidates of assignable resources (resource) exist,
 4 and the case where the contents of item (item) to be produced (produce)
 5 differ according to the selected resource (resource).

6 For example, there is the case where Machine Y, as well as Machine X
 7 can produce, or the case where Material D is necessary only for using
 8 Machine Y.

9 The class, production rule (rule) expresses the various combinations
 10 related to these operations (operation).

11 **Production rule (rule)** indicates the feature of operation (operation)
 12 and sets up the constraints for relating with these classes concerned
 13 with action (action).

14



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Figure 10 Classes Related with Production Rule (rule)

1 In the production rule (rule), operation attribute (mode) and basic
2 unit (sd) can also be targets for the constraint as the figure shows.
3 The related numerical value may be changed in order to meet the
4 constraint when executing scheduling.

5 The operations (operation) with the following features can be defined
6 by using the production rule (rule).

7 <Case 1 > If the value of “Operation A speed” in the operation
8 attribute (mode) is “high”, select “Operation A produce (high)” in the
9 production (produce) and do not select “Operaton A produce (low).”

10 <Case 2 > If putting “X” in the value of “Operation B speed” in the
11 operation attribute (mode), the absolute value of action belonging
12 to “Operation B produce” in the production (produce) is multiplied by
13 X.

14 The clause in the production rule (rule) indicates the related classes
15 with AND • OR structure. On the other hand, the constraint indicates
16 the relation between parameters in the selected relation class.
17 Penalty is the penalty in the case where the clause or the constraint
18 is not met. However the concrete description forms of them are not
19 defined in this specification.

20

1 6. Information about Operation

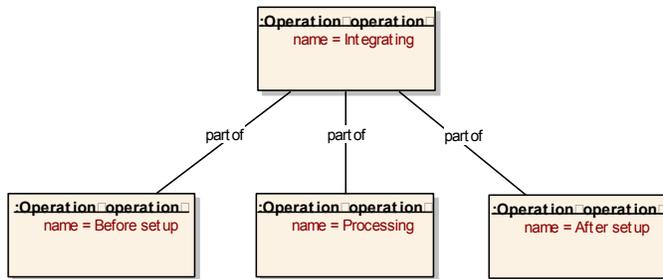
2 6.1. Operation Master

3 **Operation (operation)** is the basic element for production scheduling.
 4 Operation (operation) indicates one element of the production
 5 procedure decided beforehand. Operation (operation) produces
 6 (produce) any item (item) and consumes (consume) any item (item) as
 7 occasion demands. It is necessary to assign (assign) the resource
 8 required (resource) for producing.

9 For example, the resource (resource) to be used, the content of
 10 operation and the required number of person hours are defined in the
 11 information set up beforehand by a process designer. Such
 12 information is collected in operation (operation) as a unit.

13 Operations (operation) can have the nest relation. Individual
 14 elements of operation can be collected in one operation (operation).
 15 As the below figure shows, the before setup and the after setup can
 16 also be integrated into one operation (operation) to one processing .

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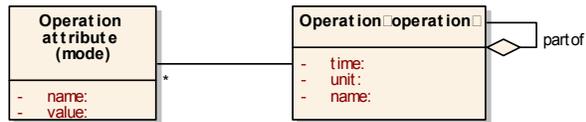
19

20 **Figure 11 Parent-child (partof) Relation between Operations**

21 The feature of operation (operation) can be expressed by the object,
 22 **operation attribute (mode)** as well as attribute. The operation

1 attribute (mode) is referred in the operation rules (rule) and the
 2 value of mode may be set up at planning or scheduling if necessary.

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Figure 12 Operation and Mode

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When the operation attribute (mode) is taken from the viewpoint of operation (operation), some operation attributes (mode), which can be selected, are set up. As comparing with this, the operation attribute (mode) for schedule (schedule) corresponds with only the attribute to be selected for actually operating (operation).

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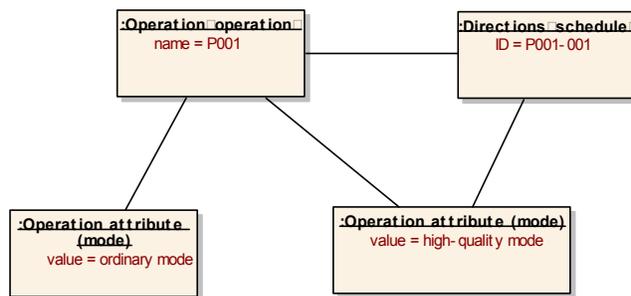
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The example in the below figure shows that Operation P001 has two modes, ordinary mode and high-quality mode. And it shows that the high-quality mode is actually selected by Schedule P001-3456. The information that either the ordinary mode or the high-quality mode must be selected is described in the production rule (rule).

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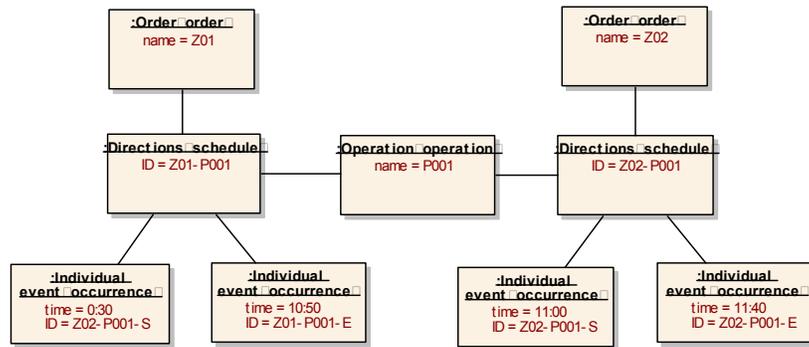
Figure 13 Opeation Mode to Operation And Schedule

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6.2. Schedule and Progress

Operation (operation) is the abstract class that can be defined beforehand, while **directions (schedule)** have the concrete objects corresponding to each schedule. Directions (schedule) are repeatedly produced in every order (order) to one operation (operation).

If there are two actual orders (order), Z01 and Z02 to Operation P001, the actual events are produced as the below figure shows.



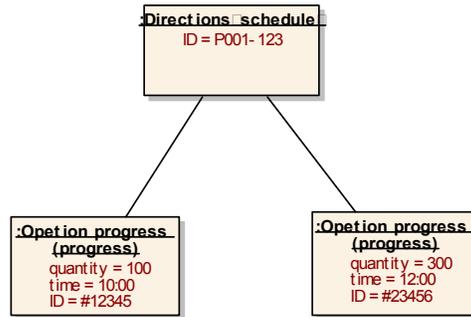
10

Figure 14 Schedule and Occurrence for Order

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Operation progress (progress) shows the result of actual operation (operation) to directions (schedule). Some progresses can be set up for one direction (schedule), because the content of progress is changing with time. The time when the progress was measured is set up in the operation progress (progress) at the same time.

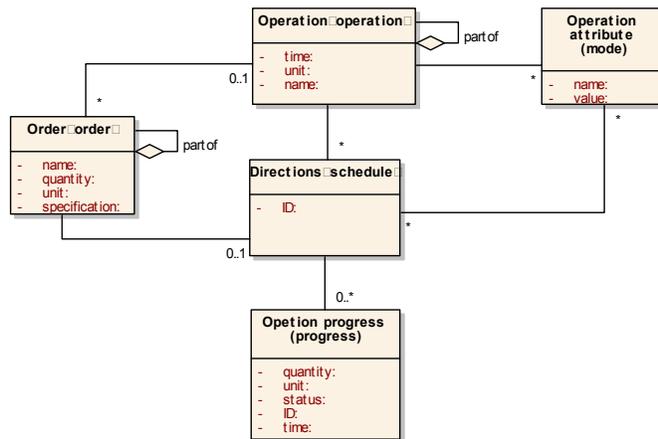
For example, the below figure shows the case where 40% of schedule Z01-P002 is ended on April 10 and 100% of schedule is ended on April 15.



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Figure 15 Schedule and Progress

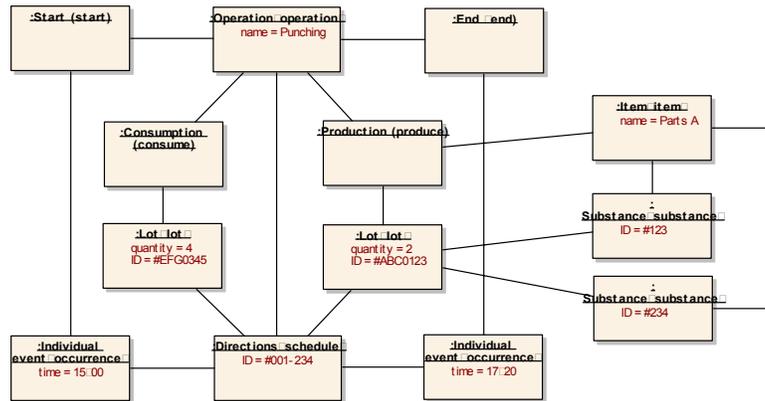
The following figure shows the relation between the classes of operation (operation), directions (schedule), operation progress (progress), order (order) and operation attribute (mode).



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Figure 16 Schedule and Related Classes

The following figure shows the relation between operation (operation) and directions (schedule), the relation between event (event) and individual event (occurrence), and the relation among production (produce), consumption (consume) and lot (lot).



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Figure 17 Concrete Example of Operation and Schedule

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6.3. Subclasses of Operation

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The subclasses of operation (operation) are fabrication (fabrication), transportation (transportation), storage (storage) and inspection (inspection).

5

6

Setup (setup) and maintenance (maintenance) are not the direct production but the related operations (operation).

7

8

Setup is the operation (operation) corresponding to the preparation required for starting operation (operation) or clearing. This operation (operation) does not produce items (item) but uses resources (resource) during operating. The resource (resource) to be used by setup (setup) is the same as the resource (resource) to be used by the target operation (operation).

9

10

Maintenance (maintenance) is the action to be regularly or irregularly executed for resources (resource). Maintenance (maintenance) does not also produce items (item) as it differs from ordinary operations (operation). The state of target resource (resource) is changed by maintenance (maintenance) and the resource (resource) is in the state to be operated normally.

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All the above subclasses of operation (operation) can be given as elements consisting of production (production). Moreover the

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1 subclasses of operation (operation) are **design (design), purchase**
2 **(purchase), and sales (sales).**

3 Design beforehand defines the operation (operation) as the master
4 information for production, and the production rules and the relation
5 between operation (operation) and item (item). When the item (item)
6 is defined by some specifications, the operation (operation) to decide
7 such specifications is design (design) too.

8 Purchase (purchase) is the action to buy materials (material), for
9 example parts and raw materials. Usually a labor in the purchase
10 section executes purchase operation, however all the period to the
11 time when a material arrives can be regarded as purchase operation.

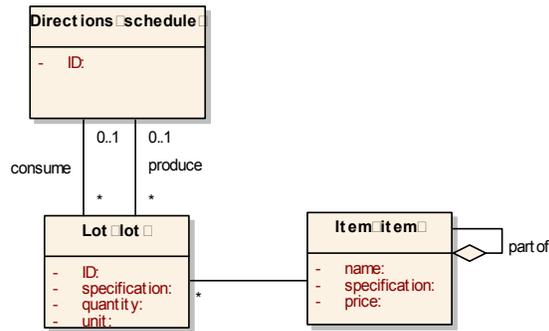
12 Sales (sales) are the operation (operation) to sell finished products.
13 However the operation (operation) to gain an order (order) before
14 finishing products and the operation (operation) to decide the
15 detailed option with a customer (customer) are included in this
16 operation.

1 7. Various Relation Information

2 7.1. Expressing Lot

3 Lot (lot) indicates the concrete existence of item (item) to be
 4 produced (produce) or to be consumed (consume) by directions
 5 (schedule). This corresponds to a part of stock (stock). The item
 6 (item) is the abstract class, while the lot (lot) corresponds to the
 7 object that can be indicated individually.

8

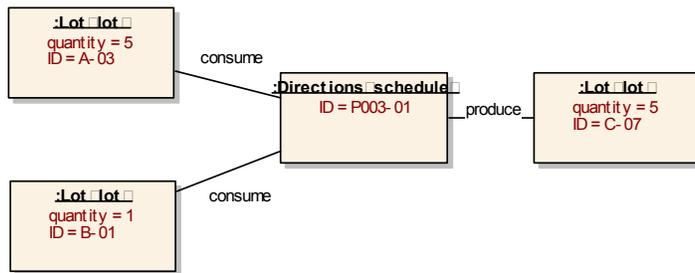


9

10 **Figure 18 Classes Related with Lot**

11 The below figure shows the case where Lot 03 of Material A and Lot 01
 12 of Material B are consumed (consume) and Lot 07 of Intermediate item
 13 C is produced by Schedule P003-01

14



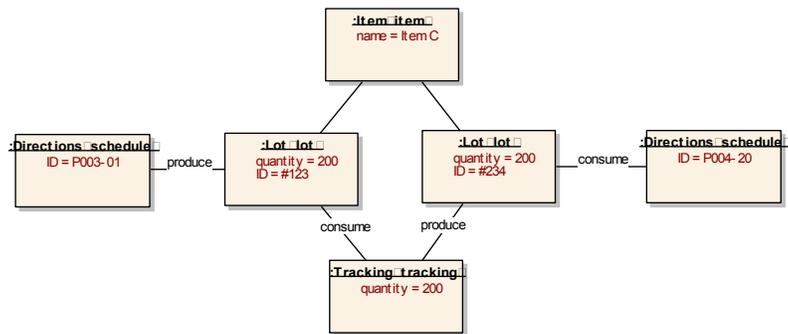
15

16 **Figure 19 Concrete Example of Lot**

1 When the directions (schedule) to produce and the directions
 2 (schedule) to consume exist for the same item (item), the lots (lot)
 3 corresponding to each schedule are set up. If the lot (lot) produced
 4 (produce) by one direction (schedule) is consumed (consume) by the
 5 other direction (schedule), the relation is expressed by **tracking**
 6 (**tracking**).

7 When Operation P004-20 consumes Lot C-07 produced by Operation P003-01,
 8 the tracking object associates the lot with the other after the
 9 consumption (consume) Lot C-08 is set up as below.

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Figure 20 Relation between Lot and Tracking

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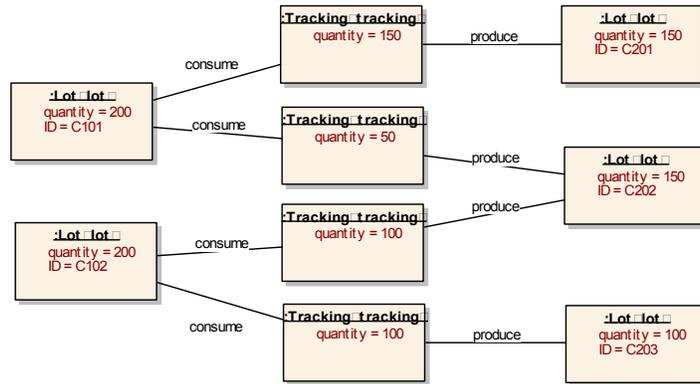
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If production lot and consumption lot are not in a one-to-one ratio,
 the below complicated relation can be expressed. In this case,
 setting up the quantity as an attribute of tracking can specify the
 details.

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Figure 21 Concrete Example of Tracking

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7.2. Expressing Task

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The special type of lot (lot) is **task (task)**. Task (task) indicates the concrete existence of resource (resource) assigned (assign) by directions (schedule). This corresponds to a part of capacity (capacity) of the resource (resource) required for executing directions (schedule).

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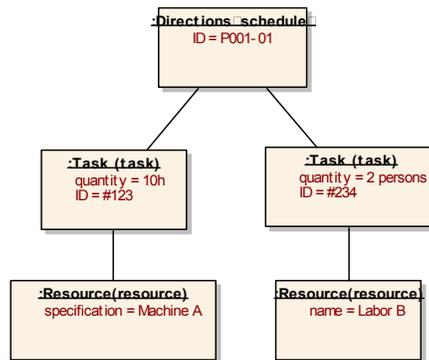
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When Schedule P001-01 executes operation (operation) using Machine Z and Labor A, the following task (task) occurs.

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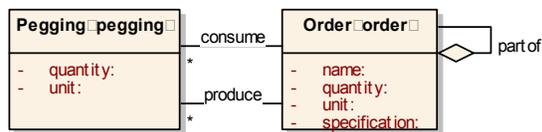
Figure 22 Concrete Example of Task

1 From the viewpoint of resource (resource), the number of tasks (task)
 2 is the same as the number of directions (schedule) to be executed.
 3 The load (load) of resource (resource) is the sum of these tasks
 4 (task).

5 **7.3. Pegging Information for Order**

6 **Pegging (pegging)** expresses the relation between some orders (order).
 7 The pegging (pegging) to associate a customer order (customer order)
 8 with each process order (process order) is called full pegging
 9 (pegging) and the pegging between process orders (process order) for
 10 a chain of processes is called single pegging.

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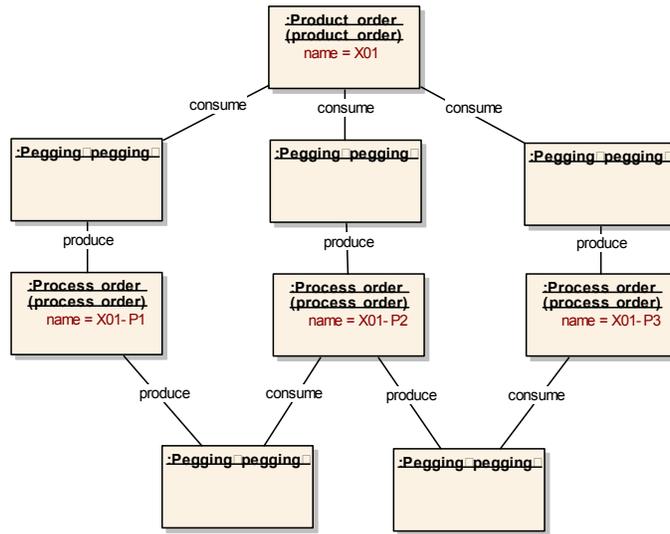


12

13 **Figure 23 Order and Pegging**

14 When three operations (operation), Operation P1, Operation P2 and
 15 Operation P3 are necessary in this order for producing a Product X,
 16 three process orders for operations, X01-P1, X01-P2, and X01-P3 are
 17 produced for product order X01 as below.

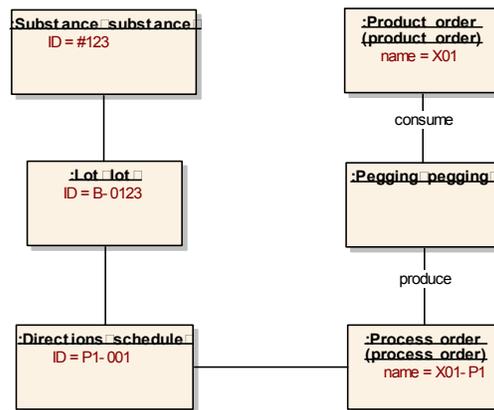
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Figure 24 Concrete Example of Pegging

The below structure is for tracing the line from individual lots (lot) to the product order (product order).



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Figure 25 Reference from Substance to Product Order

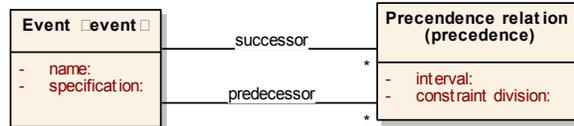
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7.4. Time Relation

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Precedence relation (precedence) expresses the time relation between two events (event). The relations between two events (event) have various examples; “Event A must occur later than Event B,” “Event A

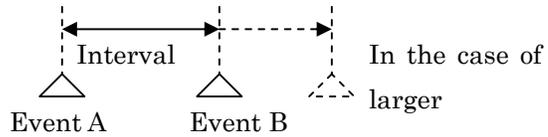
1 must occur at the same time with Event B,” “Event A must occur one and
 2 more hours later than Event B.” These situations are indicated by
 3 the parameter showing the interval between two events (event) and the
 4 attribute showing the way of comparing (<, >, = and so on) .
 5



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Figure 26 Event and Precedence

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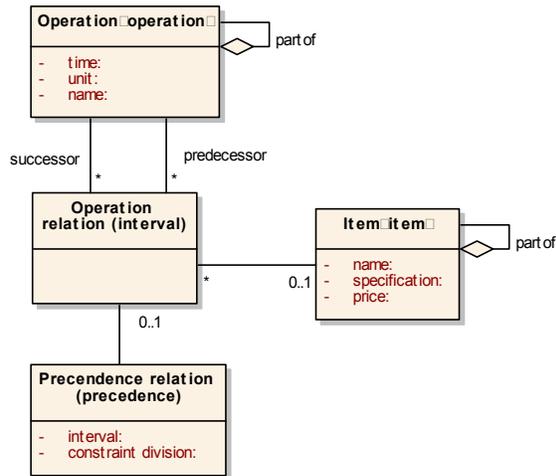
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Figure 27 Example of Using Interval Attribute

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14 **Operation relation (interval)** indicates the time relation between two
 15 operations (operation). The general operation relation is that the
 16 item (item) produced by the preceding operation is consumed (consume)
 17 by the following operation. Therefore the operation relation
 18 (interval) associates two operations with item (item). However the
 19 item (item) standing between these two operations (operation) can be
 20 omitted.

21



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Figure 28 Interval and The Related Classes

3

The time relation between two operations has the various cases, overlapping like the figure, synchronously starting, and synchronously ending besides the general relation that Operation B starts after Operation A ends. These time relations are expressed with precedence relation (precedence) between events by using start and end consisting of operation (operation).

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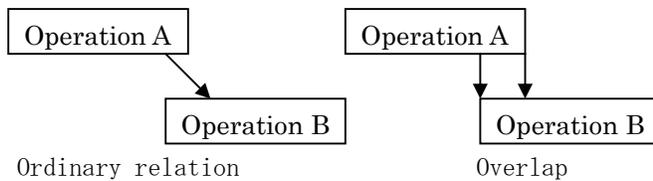
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Figure 29 Expression of Operation Overlap

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Some items (item) cannot exist for more than fixed hours after being produced because of the restrictions of quality such as the time limit for eating. Conversely, the next operation (operation) to some items cannot be executed until the fixed hours pass after producing because the quality is stabilized. This operation relation (interval) can express the features of these items (item).

15

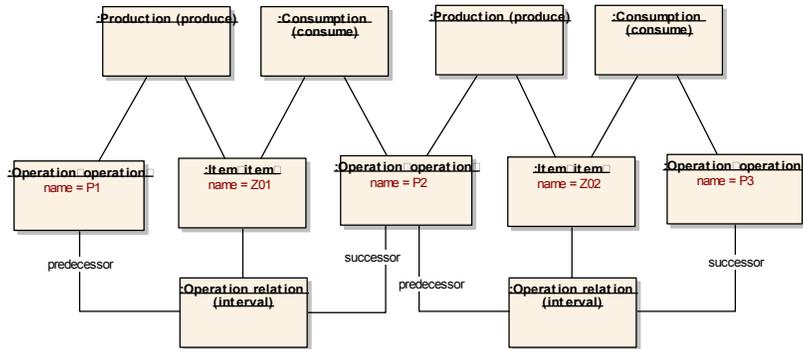
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1 The case where Operation P1, Operation P2 and Operation P3 are executed
 2 in this order and Item Z01 and Item Z02 are produced (produce) as
 3 intermediate items is shown in the below example.
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Figure 30 Concrete Example of Interval

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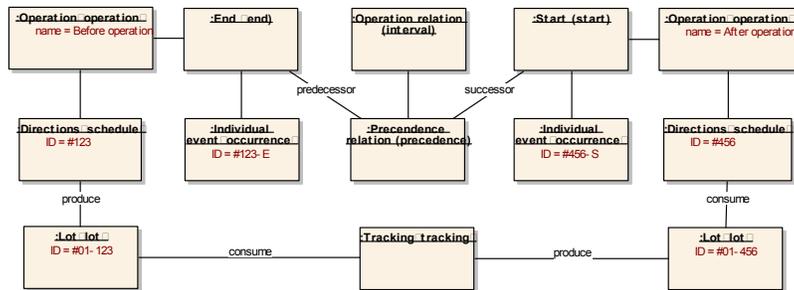
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The structure of time relation between directions (schedule) or between individual events (occurrence) cannot be directly specified. They are associated through operation (operation) and event (event) as the below figure shows.

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Figure 31 Concrete Example of Relation between Occurrences

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As the above shows, the relation between directions (schedule) can be expressed using lot (lot) and tracking (tracking).

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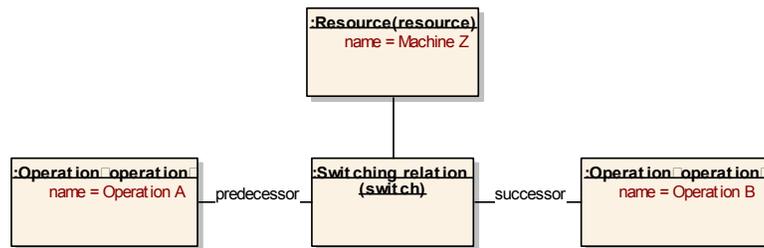
17

Switching relation (switch) is the special type of operation relation. The general operations link with each other by producing (produce)

1 and consuming (consume) the item (item) standing between operations,
 2 while the resource (resource) stands between operations in the
 3 switching relation (switch). The operation to precede (predecessor)
 4 and the operation to succeed (successor) share the same resource
 5 (resource).

6 When it takes ten minutes to switch from Operation A to Operation B
 7 in Machine Z, the switch time can be set up as the following figure.
 8 It is comparatively easy to define the complicated setting of switch
 9 time by taking abstract classes as target operations (operation).

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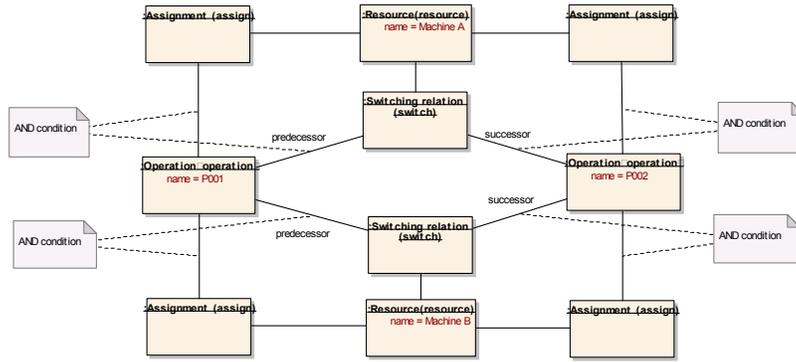
12 **Figure 32 Concrete Example of Switch**

13 The time relation between operations in the switching relation
 14 (switch) is actually expressed by the time relation (precedence) just
 15 like the operation relation (interval).

16 When a chain of two operations (operation) such as setup (setup) and
 17 processing (fabrication) must be executed on the same resource
 18 (resource), this class is used with the production rule (rule).

19 The below example shows if Operation P001 selects Resource A, the
 20 Successor P002 must select the same resource. The relation of “and“ in
 21 the figure is specified by the production rule (rule) of each
 22 operation.

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Figure 33 Constraint Chain by Switch

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7.5. Expressing Manufacturing BOM

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Manufacturing BOM (Bill of Manufacturing) differs from the current BOM

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(Bill of Material) and defines the parent-child relationship between

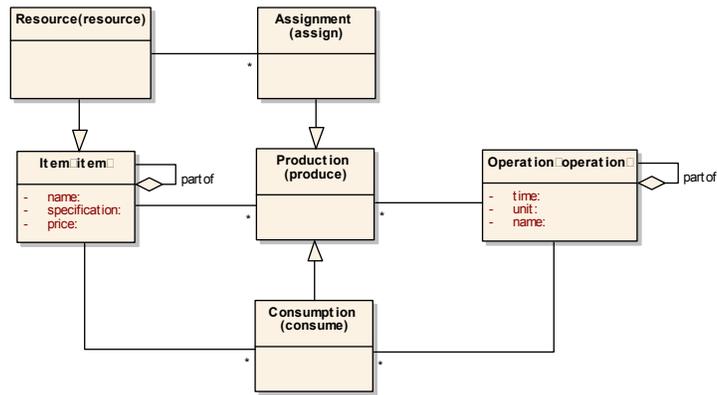
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two items by putting operation (operation) between them without

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directly specifying it.

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Figure 34 Expression of Manufacturing BOM

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When Parts A and Parts B are in the parent-child relationship to Product

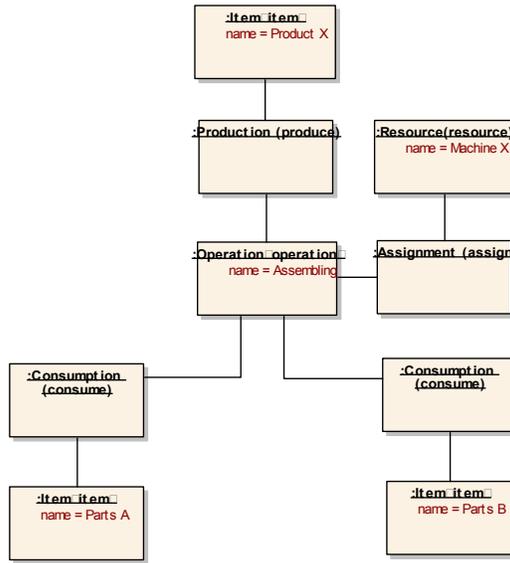
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X, the following figure shows the operation information about how

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Product X is produced from these two parts.

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Figure 35 Concrete Example of Manufacturing BOM

The numerical relation in the parent-child relationship is specified in the classes of production (produce) and consumption (consume). For instance, when ten of Parts A and two of Parts B are used for producing one of Product X, production (produce) is 1; consumption (consume) of Parts A is 10; consumption (consume) of Parts B is 2 in the figure.

1 **8. Attribute and Calculation Information**

2 **8.1. Expressing Attribute**

3 The object, **feature (feature)** expresses the attributes of item (item)
 4 changing in time. The object, **state (state)** expresses the value of
 5 attribute at each time.

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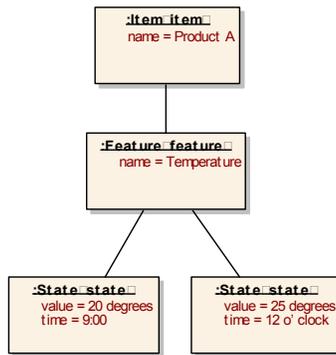


7

8 **Figure 36 Feature of Item and The Value**

9 The case where the temperature of Item A is 20 degrees at 9 o'clock
 10 and 25 degrees at 12 o'clock is represented as below.

11



12

13 **Figure 37 Expression of Different States**

14 **8.2. Subclasses of Feature**

15 The subclasses of feature changing with time are stock (stock), load
 16 (load), capacity (capacity) and location (location).

1 Stock (stock) is a kind of the feature of item (item) and indicates
2 the sum of lots (lot) belonging to the item (item).

3 Load (load) is a kind of the feature of resource (resource) and
4 indicates the sum of tasks (task) to the resource (resource).

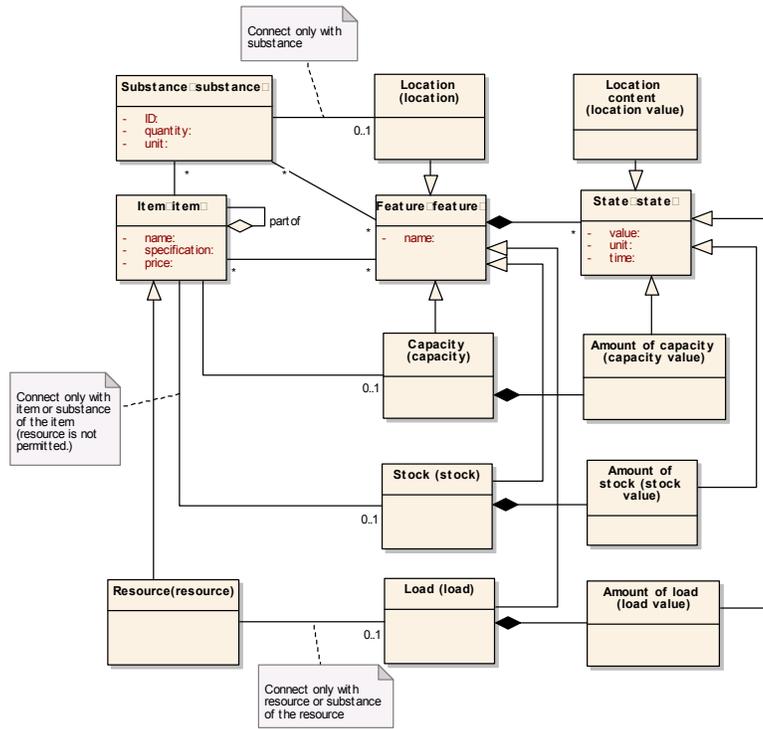
5 Capacity (capacity) indicates the maximum values to stock (stock) or
6 load (load). The values of stock (stock) and load (load) must be
7 within the limits.

8 Location (location) indicates the location of each substance
9 (substance) of item (item). Location (location) is regarded as
10 variable with time.

11 The subclasses of state (state) are the amount of stock (stock value) ,
12 the amount of load (load value), the amount of capacity (capacity
13 value) and the location content (location value) . They are objects:
14 the amount of stock (stock value) shows the state of stock (stock),
15 the amount of load (load value) shows the state of load (load), the
16 amount of capacity (capacity value) shows the state of capacity
17 (capacity), the location content (location value) shows the state of
18 location (location).

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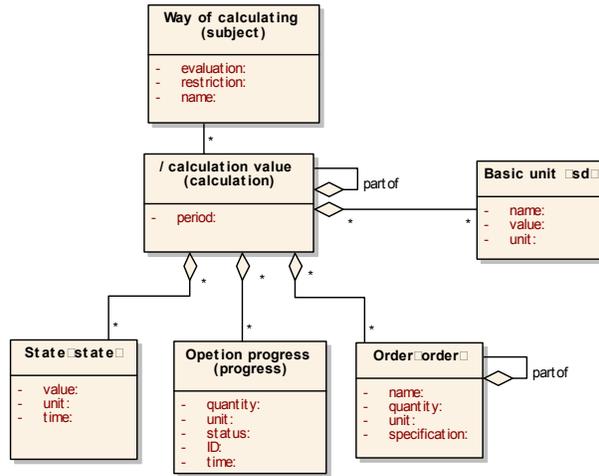
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Figure 38 Special Type of Feature of Item

8.3. Calculation Information

Calculation value (calculation) indicates the value that the attribute value (property), operation progress (progress) and order (order) of various items (item) for one period (period) are summed up. The way of calculating follows the content specified by the way of calculating (subject).

This class indicates the calculation result and has no substance.



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Figure 39 Calculation and the Related Classes

When the way of calculating (subject) is “the quantity of sales to Customer A in this month”, the related orders (order) are retrieved and the values of the applicable objects are summed up. There is also the case where the way of calculating (subject) is “the average stock level of Product B in this one week.” In such a case, the object related with the subclass, stock (stock) is retrieved from state.

Moreover, the constant value can be programmed into the calculation expression as a basic unit (ws) for calculation value (calculation). Thus the value that the operation time is multiplied by the unit cost such as “machine operation cost in this month” can be gained.

The subclasses of calculation are /cost (cost) and /profit (profit).

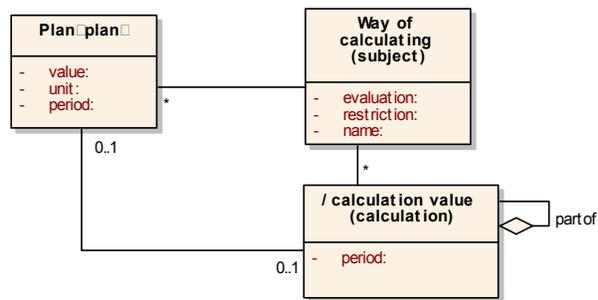
9. Information Related with Plan

9.1. Expressing Plan

Plan (plan) is the class showing the target value of calculation based on the various ways of calculating. The way of calculating (subject) is the class to indicate the way of calculating values at this time. The way of calculating (subject) can also express the way of counting the calculation value (calculation).

Plan (plan) is used with being compared with the calculation value (calculation) computed by the same way of calculating.

10



11

12 **Figure 40 Plan and The Related Classes**

13 The calculation value (calculation) is the value gotten by calculation,
 14 while plan (plan) can be directly set up. When the plan value has
 15 the relation with another plan value, it is possible to derive one
 16 plan value from the other plan value.

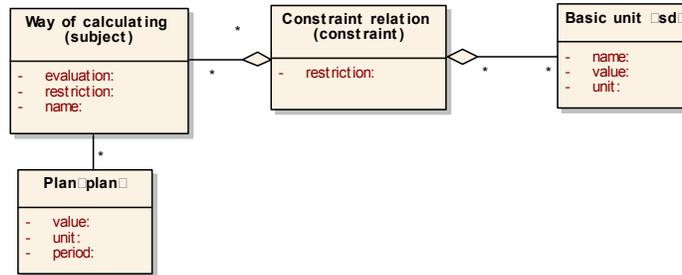
17 In the general plan, the original data of calculation is modified for
 18 the calculation value to approach to the specified plan value.

19 The various indexes can be given as concrete examples of plan, for
 20 instance "the quantity of production in the next month," "the number
 21 of person hours in the next month," and "the average yield rate in this
 22 month" and so on.

1
2
3
4

9.2. Expressing Constraint

Constraint relation (constraint) shows the numerical relation between plans. The plan value can be calculated using constraint.



5
6

Figure 41 Constraint and The Related Classes

7
8
9
10
11
12
13
If the constraint is that the total amount of the person hours in Shop A and the person hours in Shop B is 10,000 hours, the amount of person hours in Shop B is 4,000 hours when setting 6,000 hours as the person hours in Shop A. When these constraints are used, it is possible to calculate the individual plan values maximizing or minimizing the specific index, for example the linear programming problem in mathematical programming.

14
15
16
17
Basic unit (sd) is the various basic data to be used for calculation. It is used for defining the production rule besides the restriction. There are “machine operation cost per hour” and “error rate” and so on as a basic unit (sd).

18

9.3. Various Plans

19
20
21
The subclasses of plan are stock plan (stock plan), load plan (load plan), capacity plan (capacity plan), purchase plan (purchase plan) and sales plan (sales plan) .

22
23
24
The stock plan (stock plan) specifies the target value for the amount of products in stock at the beginning or end of the specific period in the future.

1 The load plan (load plan) specifies the total load (load) value (added
2 value) for the specific period in the future.

3 The capacity plan (capacity plan) specifies the maximum and minimum
4 values of the capacity (capacity) for the specific period in the
5 future.

6 The purchase plan (purchase plan) specifies the plan value of the
7 amount of purchases for the specific period in the future.

8 The sales plan (sales plan) specifies the plan value of the amount of
9 sales for the specific period in the future.

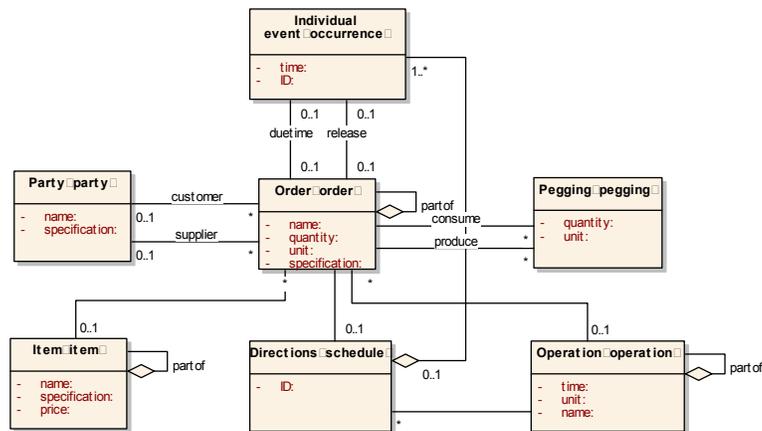
10. Order Information

10.1. Expressing Order

Order (order) is the object that requests to actually provide the specific item by the fixed time. Parties (party) such as customer (customer) issuing an order (order) and supplier (supplier) receiving an order (order) can be set up for order (order). However it is impossible to set up a customer (customer) and a supplier (supplier) at the same time.

Individual event (occurrence) information such as the start time (release) and the due time (due time) can be set up for order (order). The start time (release) indicates the time when the directions (schedule) of process order (process order) belonging to the order (order) may start. The due time (due time) indicates the time when all the directions (schedule) of process order (process order) belonging to the order must be completed.

16



17

18 **Figure 42 Order and The Related Classes**

19 In order (order), the operation (operation) may be specified clearly
 20 or may not be specified. When the operation (operation) is not

1 specified, one of the operations (operation) that can produce
2 (produce) the specified item (item) is applicable to the order (order)
3 and then the directions (schedule) are produced (produce).

4 **10.2. Product Order**

5 Order (order) can be divided into two kinds, product order (product
6 order) and process order (process order). **Product order (product
7 order)** is the order (order) issued to every product.

8 The subclasses of product order (product order) are customer order
9 (customer order) and forecast order (forecast order).

10 The customer order (customer order) is the order (order) actually
11 accepted from a customer (customer). The unofficial order
12 (unofficial order) from a customer (customer) is contained in the
13 customer order (customer order).

14 The forecast order (forecast order) is the order (order) issued in APS
15 with forecasting the expective order (order) from a customer
16 (customer). This forecast order (forecast order) will be transferred
17 to the customer order (customer order) in the future. Even if the
18 item becomes a finished product under the forecast order (forecast
19 order) and stands by for the customer order (customer order) in the
20 finished product storehouse (the case where item becomes a finished
21 product in stock), the customer order (customer order) is pegged to
22 the forecast order (forecast order), not to the stock (stock).

23 **10.3. Process Order**

24 **Process order (process order)** is the order (order) to be issued to
25 each operation (operation). Product order (product order) in the
26 former section is the aggregate of some process orders (process order).
27 If three processes make the product, the process order (process order)
28 is issued to each process and one product order (product order) is
29 issued to the whole.

1 The subclasses of process order (process order) are outsourcing order
2 (outsourcing), purchase order (purchase order), and transportation
3 order (transportation order).

4 The outsourcing order (outsourcing) is one of the orders (order) to
5 outside in the process orders (process order). This expresses that
6 the production operations such as processing and assembling are
7 executed using the outside resources (resource).

8 The purchase order (purchase order) is the order (order) for material
9 (material) to the outside supplier.

10 The transportation order (transportation order) is the order (order)
11 to request transportation or delivery when sending a product (product)
12 to a customer (customer). The transportation of material may be this
13 transportation order (transportation order) according to
14 circumstances.

1 Appendix Detailed Specification of Objects

2 This appendix shows the specification of each class of PSLX Domain
3 Objects.

4

Name	Action (action)	Upper class	No
Explanation	Changing the feature of item		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Feature (feature)		1
	Precondition (condition)		0..*
	Event (event)		1
	Production (produce)		0..*
	Production rule (rule)		0..*
Remarks			

5

6

Name	Assignment (assign)	Upper class	Production (produce)
Explanation	Relation between operation and the assigned resource		
Attribute	Name	Explanation	
	No		
Relation	Object	Role	Frequency
	Production rule (rule)		0..*
	Resource (resource)		1
	Action (action)		1..*
	Operation (operation)		1
Remarks			

7

1

Name	/ calculation value (calculation)	Upper class	No
Explanation	Calculation of various state values		
Attribute	Name	Explanation	
	Period		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Plan (plan)		0..1
	State (state)		0..1
	Order (order)		0..1
	Operation progress (progress)		0..1
	Basic unit (sd)		0..1
	/ calculation value (calculation)	partof	0..1
Remarks			

2

3

Name	Capacity (capacity)	Upper class	Feature (feature)
Explanation	Features of item, which change with time		
Attribute	Name	Explanation	
	Name (name)		
Relation	Object	Role	Frequency
	State (state)		0..*
	Item (item)		0..*
	Substance (substance)		0..*
	Action (action)		0..*
	Calculation value (calculation)		0..*
	Party (party)		0..*
Remarks	The content of feature is specified by the state (state).		

1

2

Name	Capacity plan (capacity plan)	Upper class	Plan (plan)
Explanation	Concrete value of plan		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Period (period)		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Calculation value (calculation)		0..1
	Constraint relation (constraint)		0..*
Remarks			

3

4

Name	Amount of capacity (capacity value)	Upper class	State (state)
Explanation	Capacity value of item or resource		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Time (time)		
Relation	Object	Role	Frequency
	Capacity (capacity)		1
	Calculation value (calculation)		0..*
Remarks			

5

6

Name	Precondition (condition)	Upper class	No
Explanation	Conditions for executing action		
Attribute	Name	Explanation	
	No		
Relation	Object	Role	Frequency
	Action (action)		0..*
	Feature (feature)		0..*
Remarks			

1

2

Name	Constraint relation (constraint)	Upper class	No
Explanation	Constraint relation between plan parameters		
Attribute	Name	Explanation	
	Restriction		
Relation	Object	Role	Frequency
	Plan (plan)		0..*
	Basic unit (sd)		0..*
Remarks			

3

4

Name	Consumption (consume)	Upper class	Production (produce)
Explanation	Relation between operation and the consumed item		
Attribute	Name	Explanation	
	No		
Relation	Object	Role	Frequency
	Production rule (rule)		0..*
	Item (item)		1
	Action (action)		1..*
	Operation (operation)		1
Remarks			

1

2

Name	/ cost (cost)	Upper class	/ calculation value (calculation)
Explanation	Calculation on cost		
Attribute	Name	Explanation	
	Period		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Plan (plan)		0..1
	State (state)		0..1
	Order (order)		0..1
	Operation progress (progress)		0..1
	Basic unit (sd)		0..1
	/ calculation value (calculation)	partof	0..1
Remarks			

3

4

Name	Customer (customer)	Upper class	Party (party)
Explanation	Enterprise issuing an order		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Order (order)	customer	0..*
	Order (order)	supplier	

	Feature (feature)		0..*
Remarks			

1

2

Name	Customer order (customer order)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calculation value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

3

4

Name	Design (design)	Upper class	Operation (operation)
------	-----------------	-------------	-----------------------

Explanation	Operation related with design		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

1

2

Name	End (end)	Upper class	Event (event)
Explanation	Event to end operation		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Precedence relation (precedence)	predecessor	0..*
	Precedence relation (precedence)	successor	0..*
	Action (action)		0..*

	Operation (operation)		0..*
	Individual event (occurrence)		0..*
Remarks			

1

2

Name	Equipment (equipment)	Upper class	Resource (resource)
Explanation	Requirement for producing		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*
Remarks			

3

4

Name	Event (event)	Upper class	No
Explanation	Existence changing the feature of item at one time		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		

Relation	Object	Role	Frequency
	Precedence relation (precedence)	predecessor	0..*
	Precedence relation (precedence)	successor	0..*
	Action (action)		0..*
	Operation (operation)		0..*
	Individual event (occurrence)		0..*
Remarks			

1

2

Name	Fabrication (fabrication)	Upper class	Operation (operation)
Explanation	Operation to produce item		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

3

1

Name	Feature (feature)	Upper class	No
Explanation	Feature of item, which changes with time		
Attribute	Name	Explanation	
	Name (name)		
Relation	Object	Role	Frequency
	State (state)		0..*
	Item (item)		0..*
	Substance (substance)		0..*
	Action (action)		0..*
	Calculation value (calculation)		0..*
	Party (party)		0..*
Remarks	The content of feature is specified by the state (state).		

2

3

Name	Forecast order (forecast order)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*

	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calcualtion value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

1

2

Name	Inspection (inspection)	Upper class	Operation (operation)
Explanation	Operation to inspect the quality of item		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

3

4

Name	Operation relation (interval)	Upper class	No
Explanation	Relation between operations and the applicable item		
Attribute	Name	Explanation	
	No		
Relation	Object	Role	Frequency
	Precedence relation (precedence)		1
	Item (item)		0..1
	Operation (operation)	predecessor	0..*
	Operation (operation)	successor	0..*
	Production ruel (rule)		0..*
Remarks			

1

2

Name	Item (item)	Upper class	No
Explanation	All things related with production		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Lot (lot)		0..*
	Production (produce)		0..*
	Operation relation (interval)		0..*
	Item (item)	partof	0..*
Remarks			

3

1

Name	Labor (labor)	Upper class	Resource (resource)
Explanation	Requirement for producing		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*
Remarks			

2

3

Name	Load (load)	Upper class	feature
Explanation	Feature of item, which changes with time		
Attribute	Name	Explanation	
	Name (name)		
Relation	Object	Role	Frequency
	State (state)		0..*
	Item (item)		0..*
	Substance (substance)		0..*
	Action (action)		0..*
	Calculation value (calculation)		0..*
	Party (party)		0..*

Remarks	The content of feature is specified by the state (state).
---------	---

1

2

Name	Load plan (load plan)	Upper class	Plan (plan)
Explanation	Concrete value of plan		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Period (period)		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Calculation value (calculation)		0..1
	Constraint relation (constraint)		0..*
Remarks			

3

4

Name	Amount of load (load value)	Upper class	State (state)
Explanation	Load value of resource		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Time (time)		
Relation	Object	Role	Frequency
	Load (load)		1
	Calculation value (calculation)		0..*
Remarks			

5

1

Name	Loaction (location)	Upper class	Feature (feature)
Explanation	Feature of item, which changes with time		
Attribute	Name	Explanation	
	Name (name)		
Relation	Object	Role	Frequency
	State (state)		0..*
	Item (item)		0..*
	Substance (substance)		0..*
	Action (action)		0..*
	Calculation value (calculation)		0..*
	Party (party)		0..*
Remarks	The content of feature is specified by state.		

2

3

Name	Location content (location value)	Upper class	No
Explanation	Location of item in every time		
Attribute	Name	Explanation	
	Address (address)		
	Time (time)		
Relation	Object	Role	Frequency
	Location (location)		1
	Calculation value (calculation)		0..*
Remarks			

4

5

Name	Lot (lot)	Upper class	No
Explanation	Producing and consuming item by schedule		

Attribute	Name	Explanation	
	ID		
	Quantity (quantity)		
	Unit (unit)		
	Specifction (specification)		
Relation	Object	Role	Frequency
	Item (item)		1
	Substance (substance)		0..*
	Directions (schedule)	produce	0..1
	Directions (schedule)	consume	0..1
	Tracking (tracking)	produce	0..*
	Tracking (tracking)	consume	0..*
Remarks	Only one of schedules is specified.		

1

2

Name	Maintenance (maintenance)	Upper class	Operation (operation)
Explanation	Operation to maintain equipment		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation	successor	0..*

	(interval)		
	Operation (operation)	partof	0..*
Remarks			

1

2

Name	Material (material)	Upper class	Item (item)
Explanation	All things related with production		
Attribute	Name	Explanation	
	Name (name)		
	Specificaiton (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Lot (lot)		0..*
	Production (produce)		0..*
	Operation relation (interval)		0..*
	Item (item)	partof	0..*
Remarks			

3

4

Name	Operation attribute (mode)	Upper class	No
Explanation	Attribute of operation, which is the plan variable.		
Attribute	Name	Explanation	
	Name (name)		
	Value (value)		
Relation	Object	Role	Frequency
	Operation (operation)		1

	Directions (schedule)		0..*
	Production rule (rule)		0..*
Remarks			

1

2

Name	Individual event (occurrence)	Upper class	No
Explanation	Event executed individually		
Attribute	Name	Explanation	
	ID		
	Time (time)		
Relation	Object	Role	Frequency
	Event (event)		1
	Directions (schedule)		0..1
	Order (order)	release	0..1
	Order (order)	duetime	0..1
Remarks			

3

4

Name	Operation (operation)	Upper class	No
Explanation	Basic unit to produce goods, such as processing and assembling		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*

	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

1

2

Name	Order (order)	Upper class	No
Explanation	Request to item, resource, and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calculation value (calculation)		0..*
	Order (order)	partof	0..*

1
2

Remarks	
---------	--

Name	Outsourcing order (outsourcing)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calculation value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

3

Name	Party (party)	Upper class	No
Explanation	Existence issuing or receiving order, such as enterprise		
Attribute	Name	Explanation	
	Name (name)		

	Specification (specification)		
Relation	Object	Role	Frequency
	Order (order)	customer	0..*
	Order (order)	supplier	
	Feature (feature)		0..*
Remarks			

1

2

Name	Pegging (pegging)	Upper class	No
Explanation	Pegging between orders		
Attribute	Name	Explanation	
	Quantity (quantity)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Order (order)	produce	1
	Order (order)	consume	1
Remarks			

3

4

Name	Plan (plan)	Upper class	No
Explanation	Concrete value of plan		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Period (period)		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Calculation value (calculation)		0..1

	Constraint relation (constraint)		0..*
Remarks			

1

2

Name	Precedence relation (precedence)	Upper class	No
Explanation	Time relation between events		
Attribute	Name	Explanation	
	Constraint division		
	Interval		
Relation	Object	Role	Frequency
	Event (event)	predecessor	0..*
	Event (event)	successor	0..*
	Operation relation (interval)		0..*
Remarks			

3

4

Name	Process order (process order)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1

	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calculation value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

1

2

Name	Production (produce)	Upper class	No
Explanation	Action pattern accompanying operation		
Attribute	Name	Explanation	
	No		
Relation	Object	Role	Frequency
	Production rule (rule)		0..*
	Item (item)		1
	Action (action)		1..*
	Operation (operation)		1
Remarks			

3

4

Name	Product (product)	Upper class	Item (item)
Explanation	All the things related with production		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		

	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Lot (lot)		0..*
	Production (produce)		0..*
	Operation relation (interval)		0..*
	Item (item)	partof	0..*
Remarks			

1

2

Name	Product order (product order)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1

	Calculation value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

1

2

Name	Production (production)	Upper class	Operation (operation)
Explanation	Operation related with production. The united operations for every product.		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

3

4

Name	/profit (profit)	Upper class	/ calculation value (calculation)
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Explanation	Calculation on profit		
Attribute	Name	Explanation	
	Period		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Plan (plan)		0..1
	State (state)		0..1
	Order (order)		0..1
	Operation progress (progress)		0..1
	Basic unit (sd)		0..1
	/ calculation value (calculation)	partof	0..1
Remarks			

1

2

Name	Operation progress (progress)	Upper class	No
Explanation	Result of executing schedule		
Attribute	Name	Explanation	
	ID		
	Status (status)		
	Quantity (quantity)		
	Unit (unit)		
	Time (time)		
Relation	Object	Role	Frequency
	Directions (schedule)		1
	Calculation value (calculation)		0..*
Remarks			

3

4

Name	Purchase (purchase)	Upper class	Operation (operation)
Explanation	Operation related with purchase		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Dierrections (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

1

2

Name	Purchase order (purchase order)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event	duetime	0..1

	(occurrence)		
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calculation value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

1

2

Name	Purchase plan (purchase plan)	Upper class	Plan (plan)
Explanation	Concrete value of plan		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Period (period)		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Calculation value (calculation)		0..1
	Constraint relation (constraint)		0..*
Remarks			

3

4

Name	Resource (resource)	Upper class	Item (item)
Explanation	Requirement for producing		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*
Remarks			

1

2

Name	Resumption (resume)	Upper class	Event (event)
Explanation	Event to resume the operation stopped once		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Precedence relation (precedence)	predecessor	0..*
	Precedence relation (precedence)	successor	0..*
	Action (action)		0..*
	Operation (operation)		0..*

	Individual event (occurrence)		0..*
Remarks			

1

2

Name	Production rule (rule)	Upper class	No
Explanation	Constraint items between various actions accompanying operation		
Attribute	Name	Explanation	
	Constraint (constraint)		
	Clause (clause)		
	Penalty (penalty)		
Relation	Object	Role	Frequency
	Operation (operation)		1
	Production (produce)		0..*
	Action (action)		0..*
	Operation attribute (mode)		0..*
	Operation relation (interval)		0..*
	Basic unit (sd)		0..*
Remarks			

3

4

Name	Directions (schedule)	Upper class	No
Explanation	Operation concretely developed by order		
Attribute	Name	Explanation	
	ID		
Relation	Object	Role	Frequency
	Operation (operation)		1
	Operation attribute		0..*

	(mode)		
	Individual event (occurrence)		1..*
	Order (order)		1
	Lot (lot)	produce	0..*
	Lot (lot)	consume	0..*
	Operation progress (progress)		0..*
Remarks			

1

2

Name	Basis unit (sd)	Upper class	No
Explanation	Basic data required for production		
Attribute	Name	Explanation	
	Name (name)		
	Value (value)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Production rule (rule)		0..*
	Constraint relation (constraint)		0..*
	Calculation value (calculation)		0..*
Remarks			

3

4

Name	Setup (setup)	Upper class	Operation (operation)
Explanation	Preparation for production		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		

Relation	Object	Role	Frequency
	Unit (unit)		
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

1

2

Name	Work section (shop)	Upper class	Resource (resource)
Explanation	Requirement for producing		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*

Remarks	
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1

2

Name	Sales (sales)	Upper class	Operation (operation)
Explanation	Operation related with sales		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

3

4

Name	Sales plan (sales plan)	Upper class	Plan (plan)
Explanation	Concrete value of plan		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Period (period)		

Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Calculation value (calculation)		0..1
	Constraint relation (constraint)		0..*
Remarks			

1

2

Name	Start (start)	Upper class	Event (event)
Explanation	Starting operation		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Precedence relation (precedence)	predecessor	0..*
	Precedence relation (precedence)	successor	0..*
	Action (action)		0..*
	Operation (operation)		0..*
	Individual event (occurrence)		0..*
Remarks			

3

4

Name	Management section (site)	Upper class	Resource (resource)
Explanation	Requirement for producing		
Attribute	Name	Explanation	

	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*
Remarks			

1

2

Name	State (state)	Upper class	No
Explanation	Concrete value of feature of item		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Time (time)		
Relation	Object	Role	Frequency
	Feature (feature)		1
	Calculation value (calculation)		0..*
Remarks			

3

4

Name	Stock (stock)	Upper class	Feature (feature)
Explanation	Feature of item, which changes with time		

Attribute	Name	Explanation	
	Name (name)		
Relation	Object	Role	Frequency
	State (state)		0..*
	Item (item)		0..*
	Substance (substance)		0..*
	Action (action)		0..*
	Calculation value (calculation)		0..*
	Party (party)		0..*
Remarks	The content of feature is specified by the state (state).		

1

2

Name	Stock plan (stock plan)	Upper class	Plan (plan)
Explanation	Concrete value of plan		
Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Period (period)		
Relation	Object	Role	Frequency
	Way of calculating (subject)		1
	Calculation value (calculation)		0..1
	Constraint relation (constraint)		0..*
Remarks			

3

4

Name	Amount of stock (stock value)	Upper class	State (state)
Explanation	Stock value of item		

Attribute	Name	Explanation	
	Value (value)		
	Unit (unit)		
	Time (time)		
Relation	Object	Role	Frequency
	Stock (stock)		1
	Calculation value (calculation)		0..*
Remarks			

1

2

Name	Storage (storage)	Upper class	Operation (operation)
Explanation	Operation to store item for the fixed period		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*
Remarks			

3

4

1

Name	Semifinished product (subassy)	Upper class	Item (item)
Explanation	All the things related with production		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Lot (lot)		0..*
	Production (produce)		0..*
	Operation relation (interval)		0..*
	Item (item)	partof	0..*
Remarks			

2

3

Name	Way of calculating (subject)	Upper class	No
Explanation	How to calculate the calculation values		
Attribute	Name	Explanation	
	Name (name)		
	Evaluation (evaluation)		
	Restriction (restriction)		
Relation	Object	Role	Frequency
	/ calculation value (calcaltion)		0..*
	Plan (plan)		0..*
Remarks			

4

1

Name	Substance (substance)	Upper class	No
Explanation	Concrete existence of item		
Attribute	Name	Explanation	
	ID		
Relation	Object	Role	Frequency
	Item (item)		1
	Feature (feature)		0..*
	Calculation (calculation)		0..*
Remarks			

2

3

Name	Supplier (supplier)	Upper class	Party (party)
Explanation	Existence issuing or receiving order, such as enterprise		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Order (order)	customer	0..*
	Order (order)	supplier	
	Feature (feature)		0..*
Remarks			

4

5

Name	Suspension (suspend)	Upper class	Event (event)
Explanation	Event to suspend operation		
Attribute	Name	Explanation	
	Name (name)		
	Specification		

	(specification)		
Relation	Object	Role	Frequency
	Precedence relation (precedence)	predecessor	0..*
	Precedence relation (precedence)	successor	0..*
	Action (action)		0..*
	Operation (operation)		0..*
	Individual event (occurrence)		0..*
Remarks			

1

2

Name	Switching relation (switch)	Upper class	Operaiton relation (interval)
Explanation	Relation between operations and the applicable resources on switching		
Attribute	Name	Explanation	
	No		
Relation	Object	Role	Frequency
	Precedence relation (precedence)		1
	Resource (resource)		0..1
	Operation (operation)	predecessor	0..*
	Operation (operation)	successor	0..*
	Production rule (rule)		0..*
Remarks			

3

4

Name	Task (task)	Upper class	Lot (lot)
Explanation	Amount of resources to be used by schedule		
Attribute	Name	Explanation	

	ID		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Resource (resource)		1
	Substance (substance)		0..*
	Directions (schedule)	produce	0..*
	Directions (schedule)	consume	0..*
	Tracking (tracking)	produce	0..*
	Tracking (tracking)	consume	0..*
Remarks			

1

2

Name	Tool (tool)	Upper class	Resource (resource)
Explanation	Requirement for producing		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*
Remarks			

3

1

Name	Tracking (tracking)	Upper class	No
Explanation	Relation between production and consumption among lots		
Attribute	Name	Explanation	
	Quantity (quantity)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Lot (lot)	produce	1
	Lot (lot)	consume	1
Remarks			

2

3

Name	Transportation (transportation)	Upper class	Operation (operation)
Explanation	Changing the location of item		
Attribute	Name	Explanation	
	Name (name)		
	Necessary time (time)		
	Unit (unit)		
Relation	Object	Role	Frequency
	Event (event)		1..*
	Order (order)		0..*
	Operation attribute (mode)		0..*
	Directions (schedule)		0..*
	Production rule (rule)		0..*
	Production (produce)		0..*
	Operation relation (interval)	predecessor	0..*
	Operation relation (interval)	successor	0..*
	Operation (operation)	partof	0..*

Remarks	
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1

2

Name	Transportation order (transportation order)	Upper class	Order (order)
Explanation	Request to item, resource and operation		
Attribute	Name	Explanation	
	Name (name)		
	Quantity (quantity)		
	Unit (unit)		
	Specification (specification)		
Relation	Object	Role	Frequency
	Individual event (occurrence)	duetime	0..1
	Individual event (occurrence)	release	0..1
	Party (party)	customer	0..1
	Party (party)	supplier	0..1
	Pegging (pegging)	produce	0..*
	Pegging (pegging)	consume	0..*
	Item (item)		0..1
	Operation (operation)		0..1
	Directions (schedule)		0..1
	Calculation value (calculation)		0..*
	Order (order)	partof	0..*
Remarks			

3

4

Name	Work in process (wip)	Upper class	Item (item)
Explanation	All the things related with production		

Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Lot (lot)		0..*
	Production (produce)		0..*
	Operation relation (interval)		0..*
	Item (item)	partof	0..*
Remarks			

1

2

Name	Workshop (ws)	Upper class	Resource (resource)
Explanation	Requirement for producing		
Attribute	Name	Explanation	
	Name (name)		
	Specification (specification)		
	Price (price)		
Relation	Object	Role	Frequency
	Substance (substance)		0..*
	Feature (feature)		0..*
	Order (order)		0..*
	Task (task)		0..*
	Assignment (assign)		0..*
	Operation relation (switch)		0..*
	Resource (resource)	partof	0..*

Remarks	
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1