PSLX Engineering Specification

Grand Design for Manufacturing Enterprises

PSLX-01

<Recommendation>

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Update History

Date	Version	Explanation
2003.6.26	1.0	PSLX Standard Specification recommendation(Japanese)
2003.11.25	1.0	PSLX Standard Specification recommendation(English)

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Contents

1. Introduction

1.1. Purpose of This Specification

This specification explains how to draw the grand design for manufacturing enterprises when the manufacturing enterprise introduces APS. Besides this specification aims at designing the information system that leads APS engineering proposed by PSLX to contribute to the total optimization of manufacturing enterprise, not to the partial improvement.

The content of this specification is guidelines, not rules that must be kept. However it is recommended reconstructing a business model and advancing the required system development following the content shown in this specification when the manufacturing enterprise introduces APS.

1.2. Intended Readers

The intended readers of this specification are as below.

Managers in charge of IT of manufacturing enterprises, consultants in IT strategy of manufacturing enterprises, consultants in production management, managers of SI enterprises, students of manufacturing management

1.3. Structure of Specification

The structure of the next chapter and the following chapters is as follows. First, Chapter 2 “Classifying Business Models and Indicators” shows the required information for the manufacturing enterprise to construct a new business model. Chapter 3 “Constructional Elements of APS System” explains the required constructional elements for embodying the business model using APS most efficiently.

Chapter 4 “ Basic Form of Collaboration” describes the basic collaboration forms by APS applying to the basic elements of production management. Chapter 5 “ APS Expansion Collaboration Model” describes the collaborations to realize some specific business processes, which can be executed with APS. Lastly, Chapter 6 shows the collaboration forms only by APS enabling the plans and the scheduling problems in the separate sites to link with each other.

When arguing in APS Engineering Architecture shown in the guidance, Chapter 2 corresponds to “ Manufacturing Business Model Layers”, and Chapter 3 and the later chapters correspond to “APS Collaboration Layers”.

2. Classifying Business Models And Indicators

This chapter gives the basic way of thinking required for a manufacturing enterprise to redefine a business model by itself, and provides the useful information for settling on the actual business model.

2.1. What Is A Business Model?

To begin with, Business Model has many-sided elements and can be described in various ways according to the standpoint or the purpose of a person modeling the business. This specification takes a business model for manufacturing enterprise as one system in a wide sense. And this specification selects the special features out of the relations among the external environment, the internal environment of the individual manufacturing enterprises and the active functions of the manufacturing enterprise itself. Thus it takes the approach that makes a business model outline clear.

When deciding on a business model, this specification places the tactics or the strategy possessed by a manufacturing enterprise in the relations with customers, with suppliers, with other competition companies or with the inside resources or assets. Finally this specification forms them into an indicator or a subject. The indicators and the subjects given there are constructed and the relation with each function possessed by the manufacturing enterprise is defined. It is very important to define that who the true customer is, who the true competitor is, what the true management resource to be protected and developed is.

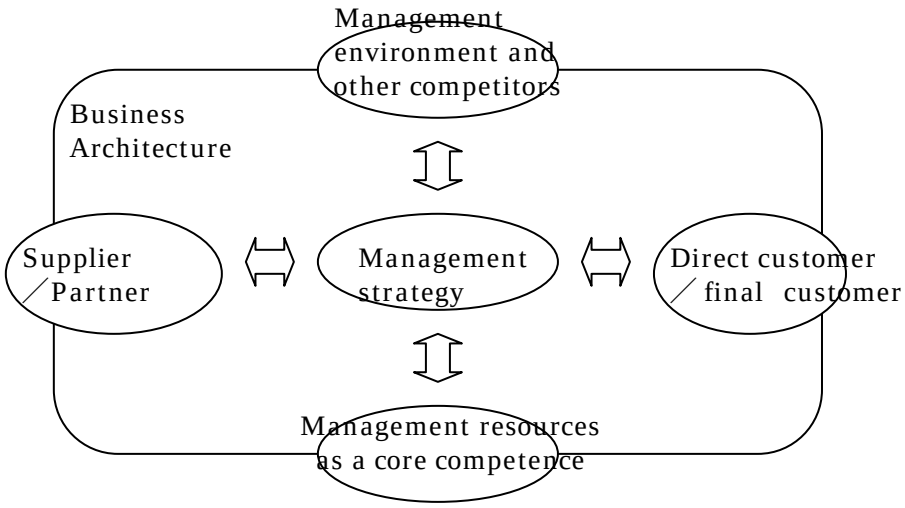

Figure 1　Basic Elements of Business Model

In this chapter, the business model is handled with considering the business architecture in a wide sense.　Business architecture is the structure that becomes a prerequisite when the individual manufacturing enterprise develops business, and beforehand exists depending on industry type or form.

For example, the prerequisite for a personal computer maker differs entirely from the prerequisite for an automobile manufacturer in product structure, process structure and sales method.　Therefore the business model cannot be handled with ignoring the business architecture.　However, each enterprise can select the business architecture.　Because even if products are the same, there are many cases where the architecture dealing with the low-cost general products differs from the architecture dealing with the customer-made quality goods.

Business process is what a business model is handled from the viewpoint of information flow, or the viewpoint of value.　In the business process, each element of a business model is placed as one conversion function in the flow.　Thus the outline of a business model can be decided concretely to some degree by regarding a business

model as an aggregate of business processes and defining a constructional element in every function. However it is necessary to recognize that only one side of a business model can be described

This chapter doesn't define the business model actually, but presents only the information required for each manufacturing enterprise to redefine its own business model. At first, it gives the business functions to be a constructional element of a business model. Then it shows the indicator to objectively evaluate the achievement degree of the subject related with the functions.

2.2. Functional Elements of Business Model

As the guidance points out, when discussing APS functions, two viewpoints are important: the viewpoint of supply chain and the viewpoint of engineering chain like the chain in figure 2. This chapter reconfirms the general functions of a manufacturing enterprise in line with these two viewpoints, because a lot of operational business can be classified with these two axes except highly marketing or strategic investment items.

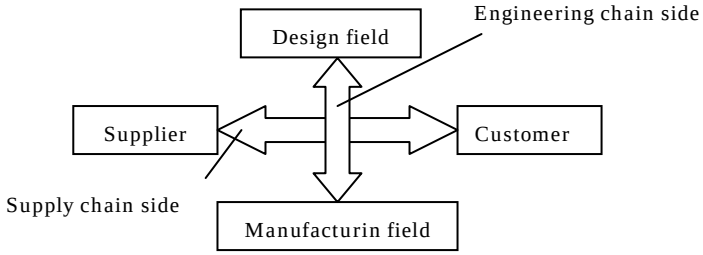

Figure 2 Classifying Function by Two Sides

The functions listed in this section individually execute the autonomous decision-making to a certain extent. For placing the functions in the whole enterprise accurately, the functions must be able to link with each other with putting the integrated decision-making by APS in the manufacturing enterprise on the core. It is important to separate the peculiar information of function and the information shared between functions, to open the way of accessing, and to use the original

execution and the collaborative execution for each activity appropriately.

When defining the business model for manufacturing enterprise, all of functions shown here need not be contained inside the enterprise. Because it is the important point that the boundary between the inside and the outside of enterprise is fixed. It is natural that the business model must have the element of integrated decision-making placed on the center of enterprise.

✧ **Supply chain side**

When considering a supply chain, the manufacturing industry pays attention to how to make the chain work smoothly between customer and supplier. Figure 3 shows the business functions related with the supply chain. When thinking about dealing with a customer, three functions --- sales plan, order management, shipping management--- are given.

Sales plan	The management section mainly creates the medium and long-term sales plan. This plan is decided with considering forecasting, opinions from each customer and salesman's target value.
Order management	manages various processes from an inquiry to an actual order as actual exchange with a customer. The forecast order by a person in charge of management and an unofficial order from a customer are also targets.
Shipping management	ships products by the order from a customer. Sometime the form or the timing for shipping may be adjusted, if needed.

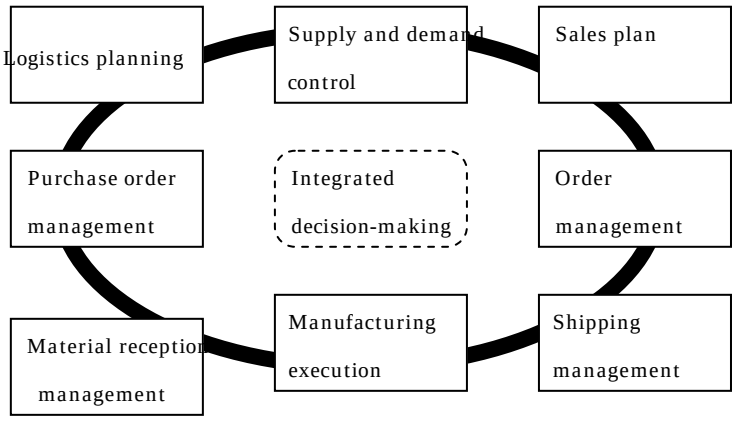

Figure 3　Functional Elements of Manufacturing Enterprise （viewpoint of SCM）

When watching the relation with supplier, the following functions --- logistics planning, purchase order management, material reception management--- are listed.

Logistics planning	creates a plan to supply the required materials including supplier management. It keeps an outsourcing factory which executes the in-house process instead of the company such as outsourcing.
Purchase order management	manages materials order to suppliers and outsourcing. It manages purchase orders and the due time according to the calculation results by MRP and the material order method.
Material reception management	receives, examines and accepts the materials ordered to suppliers. The additional supply may be required if the plan is different from the actual condition.

On the other hand, two functions: supply and demand control and manufacturing execution exist between two sides, which are the business function for customer and the business function for supplier

Supply and demand control	adjusts the amount of supply and demand from the viewpoint of the whole enterprise. Sales plan and capacity plan may be changed if necessary.
Manufacturing execution	actually executes manufacturing according to a plan and scheduling results. The way of manufacturing may be changed to take measures to the unexpected events on the manufacturing field as occasion may demand.

Production plan and scheduling function are placed on the core by integrating the above functions.

✧ **Engineering chain side**

From the viewpoint of engineering chain, which is another important side of APS, the flow of production development to meet the true demand from customer is backed up. All functions required by manufacturing enterprise are fulfilled only by having both supply chain and engineering chain. Figure 4 shows the important functions from the viewpoint of engineering chain.

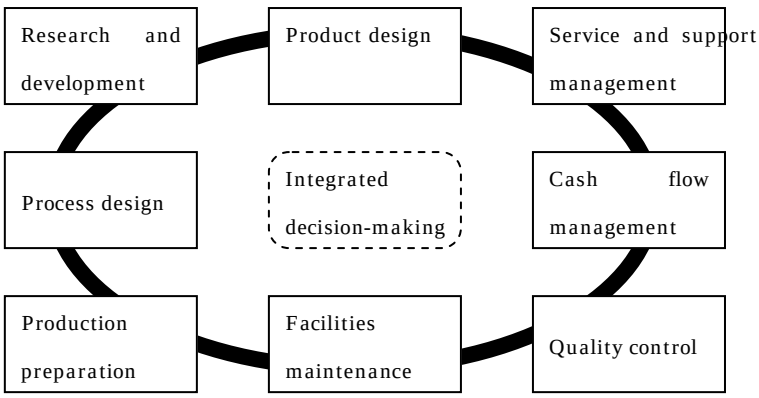

Figure 4 Functional Elements of Manufacturing Enterprise （viewpoint of ECM）

In the engineering chain, various functional elements are classified into two sides, which are the target and the means for manufacturing products. The targets are the service and support management function at scene of using a product, cash flow management for connecting the market value of product to the cost, and quality control for answering the market demand.

Service and support management	supports the scene where a product is actually used in the market, and offers the service to meet the request from customer after selling the product for connecting the market needs with a product.
Cash flow management	plans and controls the cost for guaranteeing that the result of making productions leads to the profit exactly. Especially it grasps the production activities from the viewpoint of how the profits are gained by the activities, not from the viewpoint of the cost, and it makes the decision.
Quality control	The quality of product or manufacturing process is taken correctly and it is discussed what actions must be taken to get the target quality.

Research and development, process design and production preparation can be given as functions for the concrete means to achieve these objectives. The engineering is embodied more in order of research and development, process design, and production preparation.

Research and development	designs new engineering to fill up the gap between customer's needs and the existing engineering when the engineering cannot be applied for embodying the needs into a product.
Process design	Hardware and software consisting of manufacturing equipment and workers are required to make products. In process design, the direct system for producer's side is designed.

Production preparation	completes various facilities and production lines including trial manufacturing for making products with actually operating the production process. It includes the actions that rearranges a line or extends a factory.

Product design and facilities maintenance are the functions to apply the means of realizing the targets of enterprise for the targets of the market demand as the above shown. The former is non-continuous function, but the latter is a continuous function.

Product design	clarifies the customer's needs and gropes for the function of product and the way of realizing the customer's needs. As the result, the production structure and the manufacturing method are decided and the master information is clarified.
Facilities maintenance	Even if a production line is excellent, a fault or failure always occurs. Facilities maintenance always keeps a factory in the best condition for meeting the maximum of customer's needs.

In the same way as a supply chain, the integrated decision-making is placed on the center of engineering chain with unifying the above functions. For the integrated decision-making in the engineering chain, the important elements are plan and scheduling in case of grasping a product in the entire product lifecycle.

2.3. Classifying Indicators

There are numberless indicators to evaluate manufacturing enterprise. Therefore in the present circumstances, it is very difficult to decide which indicator is used for evaluating the mechanism of the company and for measuring the effect of APS introducing. This section shows the important viewpoint for classifying various indicators and some samples on each viewpoint.

When settling on the grand design, each manufacturing enterprise must choose the indicators supposed to be important for the enterprise out of the indicators listed in this section or the originally added indicators and construct the indicators. The information obtained in this section must be a valuable map on advancing IT in manufacturing enterprise.

In APS, four viewpoints are important: customer viewpoint, supplier viewpoint, viewpoint of efficient management resource and viewpoint of information system in figure 5.

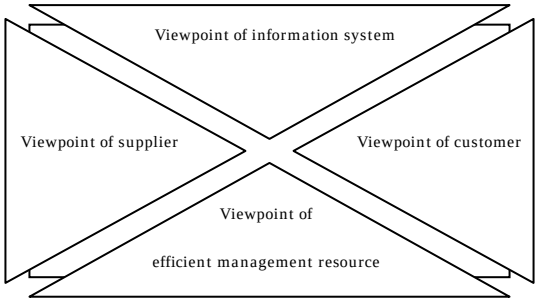

Figure5 Constructing Indicator

✧ **Viewpoint of customer**

The indicator representing how a customer for a manufacturing enterprise is satisfied is shown in the viewpoint of customer. When considering that the start point of enterprise activity is a customer, this viewpoint is the most important among the viewpoints. The viewpoints of customer are as follows.

Immediate shipping rate	rate of the case where a product is shipped instantly for an order without keeping a customer waiting.
Sold out rate	rate of the case where the product required by a customer cannot be provided by the customer due date conceded to a maximum extend.
Supply	average number of days from the time when

lead time	a customer orders a product to the time when a customer receives the product
On-time delivery rate	rate of the case where a product can be shipped on the due date promised to a customer
Rate of available to promise	rate of the case where the due date to customer's inquiry can be promised within the term expected by the customer
Selection range of specification	range (defined indicator) where a customer can specify an individual specification of a product according to each request
Design change cycle	cycle where a model and design can be changed according to the change in needs
Design recovery speed	speed of processing the complaint against failure of a product on the production side

✧ **Viewpoint of supplier**

How easy to make a product or how easy to get profits for supplier is shown with an indicator in the supplier viewpoint. For keeping the cooperative relation between a maker and a supplier, it is very important to construct the better business relation for both sides, not to achieving the aim at the cost of supplier.

Precision of unofficial order	rate of the actual order to the unofficial order notified to a supplier
Responsible days of reception	number of the preceding days with the purchase responsibility in the purchase plan notified beforehand as the unofficial information
Time to spare for due date	rate of the average supply lead time specified at purchasing a product to the lead time when

supply is available with time to spare

Purchase balancing rate	whether the content of purchase are balanced on the point of price or load when taking the bucket of month or week
Purchase order lot size	rate of the average number of ordered products per one order to the suitable lot size for manufacturing
Plan and schedule accessible level	open level of the information that is required for supplier to forecast demand such as plan information or stock information (defined indicator)

✧ **Viewpoint of efficient resource management**

The important items for manager are how efficiently production resources such as the present machinery or facilities of each enterprise are used, how efficiently profits are gotten from investment and the gathered talented persons, and how the talented persons are trained for the future. It is important to have the viewpoint of efficient resource management, like workers, things and money possessed by the enterprise in order to achieve a purpose and an ideal of each enterprise.

Load balancing rate	rate of fluctuations in the load of bottleneck process in the totaled unit of day or week
Average number of inventory days	For how many days the finished product inventory or the inventory of work in process are kept, averaging the amount of orders a day
Machine usage rate	rate of the actual operation time to the operation available time in each machine or facility

Ratio of common parts	comparison between the ratio of the number of parts to the number of product items and the ratio of the average number of parts in one product
Dead inventories rate	rate of the manufacturing costs of products, materials and works in process that are unsold for the fixed period and more and don't move
Multi-skilled labor rate	rate of the workers who have some skills and can operate various processes according to production change
Number of results in QC activities	number of QC activities that get the results at higher level than the fixed value
Motivation level	Whether employees have a sense of purpose and develop their abilities through enterprise activities with reason for doing so (fixed indicator).
Manufacturing cost rate	rate of manufacturing cost (including the fixed cost) to sales price. The fixed cost is distributed by a cost driver.
Through-put	rate of the profit that is the sales price per the fixed term minus the direct cost (only material cost)
Cash to cash cycle	average number of days from paying cash for purchasing materials to collecting cash by sales

✧ **Viewpoint of information system**

Information system described in this section is the system synthesizing the flows of information and value in human work, not the closed world consisting of a computer and a network device only. In short, the

information system without using a computer exists. However the important problem in the present business environment is how the information system in the enterprise is advanced and how the system is replaced with the mechanism using a computer and network.

Planning cycle	cycle to create a plan, including the case where the created plan is remade based on results.
Precision of planning results	rate of the case where the created plan is not modified till the plan is actually executed.
Speed for adjusting schedule	speed that a plan can be modified for the unexpected situation, or a modification cycle
Rate of common terms	Whether the terms used for transmitting information in the enterprise or between the related enterprises are common by standardizing or not.
Rate of information sharing	Whether the information required for process link such as plan information between sections or enterprises is shared or not.
Rate of digital information usage	How much various information in the production field is described on a computer, not on paper.
Consistency of master data	Whether the master information for enterprise is integrated and managed, and whether there is a contradiction or mismatching with the reality (fixed indicator).
Level of reusing production knowledge	How much information and knowledge collected in each field are stored in the re-usable form and actually reused.

3. Constructional Elements of APS System

For concretely describing the grand design for manufacturing enterprises, the business models for individual enterprises must correspond to each other in the information system and must be detailed gradually. Thus it is important to design the mechanism of collaboration (collaborative decision-making) about how each functional element constructing the system behaves under the various circumstances and achieves the purpose for the whole.

This chapter first regards the collaboration mechanism based on APS concept as a concrete means of realizing the business model discussed in the former chapter and embodies the mechanism. The second layer "APS Collaboration Layer" in APS Engineering Architecture shown in "Guidance（PSLX-00）" is discussed from this chapter.

This chapter beforehand explains the outlines of constructional elements that appear in individual collaborations described in the next and later chapters. The constructional elements of collaboration are classified into two classes, agent and object.

3.1. Description of Agent

The agents described in this section are APS agents in "Guidance (PSLX-00)", and active elements making APS. In APS, the agents with individual special feature realize the various functions shown in the preceding chapter with active decision-making. At the same time, the agents always plan and execute the action with collaborating in the framework of "integrated decision-making," which handles individual functions by crossing them (moving from function to function.)

Because especially planning agent and scheduling agent have the important parts in APS among the below agents, the contents of them are explained more minutely in Part 2 "APS Agent Model" in this specification.

- ✧ **Policy management agent（1）**

When executing production, first this policy management agent decides a production policy. Production policy described is decision-making about how the management resources are distributed from a standpoint of enterprise management. To put it concretely, it is the information about when, which, how many product families are made for market demand. Policy management agent decides the production policy from the management viewpoint with considering the financial conditions of enterprise.

✧ **Planning agent（2）**

Planning agent creates various plans about production. The plan described in this section is what decides the information about which, how and how long an item is produced, or the information about the resource specification and the capacity for producing. Planning agent decides these data on the basis of any indicator with considering the entire balance of these data and integrating them

✧ **Scheduling agent（3）**

Scheduling agent follows the plan specified by planning agent, and adjusts the various necessary operations on the time axis with considering spending resources and materials required to put the plan into action actually. Scheduling agent searches the solution with considering the unique constraints in various production fields to bring a scheduling result close to a reality as much as possible.

✧ **Product design agent（4）**

Product design agent generates the detailed information about functions and configuration of product itself and about how to use the product. The generated product information is defined by being structured into parts of a product and so on. These structures of parts or specification options are the important information for deciding the way of manufacturing.

✧ **Process design agent（5）**

Process design agent designs the production process that is equipment to transcribe the design data of various products into concrete products.

Besides the jobs of process design agent are newly building a factory itself and extending a production line. At the same time, process design agent defines various rules and constraints to make individual products when designing these production processes.

✧ **Purchase plan agent（6）**

Purchase plan agent follows the content of production policy or production order plan and supplies the required materials from the outside suppliers. And outsourcing with supplies management is also a target. This agent manages supplier to keep the losses to a minimum in regard to the production spreading over some enterprises.

✧ **Order management agent（7）**

Order management agent creates sales plan and manages the actual customer order for selling products in business section. This agent stands between a customer and a production field and supports the business section with processing the urgent order, available to promise and phased individual specification.

✧ **Cost control agent（8）**

Cost control agent correctly grasps each manufacturing cost for the production individually executed by enterprise and provides the basic information for deciding the most suitable way of producing from the viewpoint of cash flow. The master information required for cost calculation such as a control unit is managed and updated by this agent whenever necessary.

✧ **SC management agent（9）**

SC (supply chain) management agent manages the information of the related enterprises on the supply chain such as the enterprises related with physical distribution or transportation, supplier, partner, not to mention customer. And this agent executes an action to keep a network most optimized for enterprise all times. To evaluate the suppliers and to search a new constituent member are also very important jobs.

✧ **Transportation management agent（10）**

Transportation management agent creates the plan for transportation between enterprises or in an enterprise and manages executing a plan actually. When executing the production spreading over some sites, it is important to synchronize production process and transportation process by this transportation management agent.

✧ **Capacity control agent（11）**

Capacity control agent adjusts the capacity to keep the required production capacity for realizing a production plan. The adjustable range of physical production capacity is limited for each factory. This agent selects the best way out of various choices, for instance extending a facility, prolonging operation time, or using outside production resources and so on.

✧ **Stock control agent（12）**

It is necessary to efficiently use stock in order to assimilate the change in demand in the market and to realize the balanced production as much as possible. Stock control agent makes the decision about which position, which time and how many inventories should be possessed in the supply chain.

✧ **Manufacturing execution agent（13）**

Manufacturing execution agent executes various managements when executing actually manufacturing under the created manufacturing schedule. It is possible to say that the core function of MES （Manufacturing Execution System）is one form embodied by this agent. Manufacturing execution agent directly manages individual devices and workers and defines the corresponding relation between production instruction and progress.

✧ **Facilities maintenance agent（14）**

Facilities maintenance agent plans the various operations like maintaining and so on and manages the operations for a production system to be able to provide the expected capacity all time. Facilities maintenance agent always monitors the condition of production

resources. Whenever finding the abnormal condition, this agent decides the measures and controls the situation.

✧ **BOM management agent（15）**

BOM management agent manages the engineering information for Planning and Scheduling on production. The former BOM had mainly the information of parts lists, but this agent has also the information of process procedure and provides the basic information for simultaneously calculating resource load and material requirement, which is one special feature of APS. This agent also manages the items of BTO type products that the final product is decided by combining various specifications.

✧ **Option control agent（16）**

Option control agent manages the order including the vagueness that all specifications of product are not decided beforehand. And this agent manages the term from the time to firstly receive an order to the time to lastly decide all of specifications. Option control agent provides the information of the decided part for starting to produce partially in this term, and at the same time, provides the information for asking for the specification decision of the undecided parts.

✧ **Pegging control agent（17）**

Pegging control agent manages the correspondences between a customer order and a production order, or between a production order and individual manufacturing schedule. In short, it corresponds to pegging control. This agent processes the various cases and requests that are from the simple pegging such as product number management, to the pegging with dividing or joining lots such as MRP.

✧ **Federation management agent（18）**

Federation management agent supports the interactive communication when the unformatted information about production is exchanged between enterprises or organizations. Generally a great deal of person hour is needed to exchange the information over the wall of organizations because of difference of terms or data formats. But this

agent assimilates each local difference and enables the information exchange with high reliability.

3.2. Description of Object

The objects described in this section are the passive data aggregate used for a definite purpose to some extent. These data have various business elements described in Chapter 2 or the original structure of APS required for executing integrated decision-making there. The following shows supplementary descriptions of objects as the minimum information required for explaining the collaborations by agents. The systematic structure of object models or the concrete content of object including the objects described here are explained in detail as “PSLX Domain Object” in Part 3 of this specification.

✧ **Financial statement object（1）**

Financial statement object is the object showing the financial conditions in enterprise.

✧ **Market demand object（2）**

Market demand object is the object indicating the potential needs of market, forecast information about customer order and unofficial information.

✧ **Production policy object（3）**

Production policy object is the object that represents the basic policy on production such as when, what, how many products are produced.

✧ **Production order object（4）**

Production order object indicates the information about what, how many and how long products must be made as an order in a unit of the final product. This is the request to the production section.

✧ **Customer order object（5）**

Customer order object is the object that directly indicates the request from a customer and corresponds to production order finally.

✧ **Purchase order object（6）**

Purchase order object shows the purchase order sent to a supplier for keeping the required materials for a production order.

✧ **Manufacturing schedule object（7）**

Manufacturing schedule object shows the information about the operation to actually produce for individual production resources. It includes the information corresponding to the operation schedule such as start time or end time to operate.

✧ **Sales plan object（8）**

Sales plan object indicates the forecast value or the target value of the number of products sold to customers in the future. The value provided by sales plan object is used as forecast information for planning a production order.

✧ **Stock plan object（9）**

Stock plan object expresses the expected stock level in the future generated by stock control agent.

✧ **Transportation schedule object（10）**

Transportation schedule object indicates the future planning or scheduling about transportation operation in an enterprise or between enterprises specified by transportation management agent.

✧ **Maintenance instruction object（11）**

Maintenance instruction object expresses the information about maintenance scheduling.

✧ **Supplier object（12）**

Supplier object expresses the concrete information about each enterprise used by SC management agent.

✧ **Transportation capacity object（13）**

Transportation capacity object expresses the resource capacity of transportation facilities etc. required for transporting.

✧ **Production capacity object（14）**

Production capacity object expresses the resource capacity required to produce such as production facilities or machines. And also it includes the information about the usable time of each resource.

✧ **Manufacturing progress object（15）**

Manufacturing progress object expresses the manufacturing progress of how many products have actually been made under manufacturing schedule and the operation results of how many production resources have been used.

✧ **Production rule object（16）**

Production rule object expresses the constraints or the rules considered when actually producing. In production scheduling, the realistic scheduling is generated under this rule.

✧ **Product inventory object（17）**

Product inventory object has the time series information about where and how many goods are stocked for every product. It includes the inventory information about the stock outside of enterprise such as distributor's stock.

✧ **Material stock object（18）**

Material stock object expresses the inventory information of the materials not to be a product yet or works in process.

4. Basic Collaboration Forms

This chapter shows the most basic examples for various collaborations required for realizing APS. Chapter 2 describes that it is necessary to make the integrated decision to control the operation functions considered by APS. This is the basic information for constructing the mechanism for executing concretely integrated decision-making.

Thirteen typical collaborations are described dividing into three groups: about production item, about production resources and about supply chain.

4.1. Decision-making on Production Items

At first, the examples of collaborations making decision about the produced items are given in this section.

✧ Policy management collaboration（1）

This collaboration creates the production plan including the indicator about persons or funds by standing on the managing viewpoint such as business development or product development for what, when and how many products are made. This collaboration becomes the medium- and long-term plan comparatively.

Name	Policy management collaboration
Agent	Policy management agent, Planning agent, SC management agent
Object	Market demand object, Production capacity object, Financial statement object, Production policy object

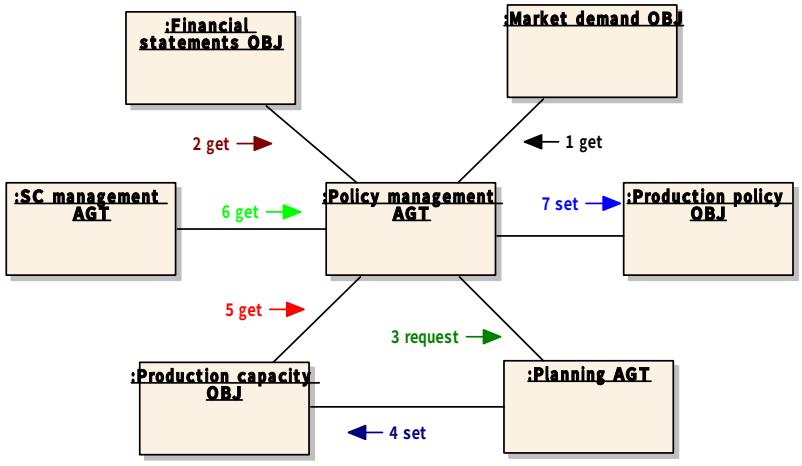

Figure 6　Policy Management Collaboration

✧ Production order planning collaboration（2）

This collaboration decides the required amount of production for preparing materials needing prior arrangements, or for adjusting the production capacity in every finished product as a production order plan.　However the obtained amount may be change with time.　In the production order plan, planning agent and scheduling agent exchange information closely and the plan guaranteeing that the scheduling is executable to some degree is given.

Name	Production order planning collaboration
Agent	Planning agent, Scheduling agent, Capacity control agent, Order management agent
Object	Production policy object, Market demand object, Production order object, Product inventory object, Stock plan object

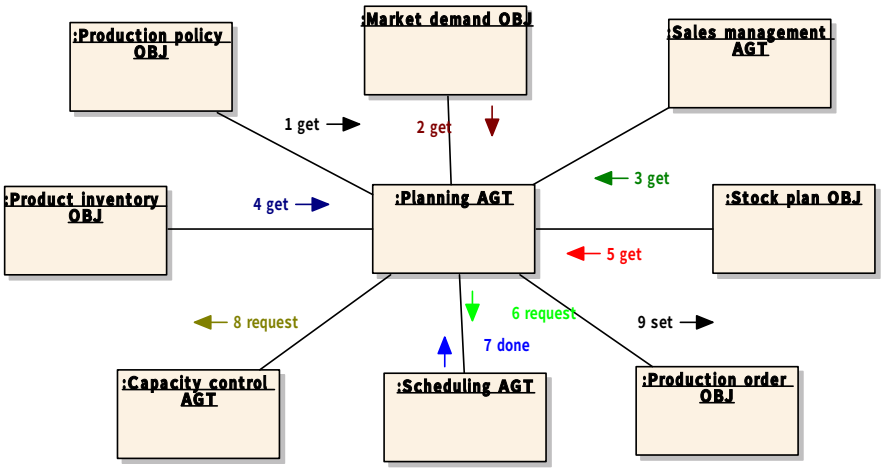

Figure 7　Production Order Planning Collaboration

✧ Manufacturing indication planning collaboration（3）

This collaboration creates the plan in an operation unit for every process actually executing manufacturing.　This plan becomes the final indication to the manufacturing field.

Name	Manufacturing indication planning collaboration
Agent	Scheduling agent
Object	Production order object, Production capacity object, Material stock object, Production rule object, Manufacturing progress object, Manufacturing schedule object, Maintenance instruction object

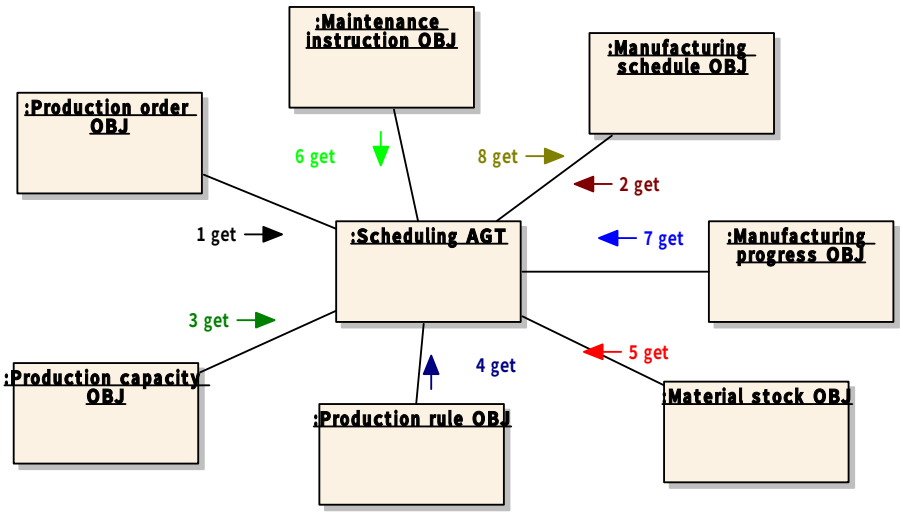

Figure 8　Manufacturing Indication Planning Collaboration

✧ Due date estimation collaboration （4）

When any new operations are necessary for the order from a customer, this collaboration answers the due date by scheduling those operations temporarily.

Name	Due date estimation collaboration
Agent	Pegging control agent, Scheduling agent, Order management agent
Object	Production order object, Product inventory object, Manufacturing schedule object, Manufacturing progress object, Production capacity object, Material stock object, Production rule object

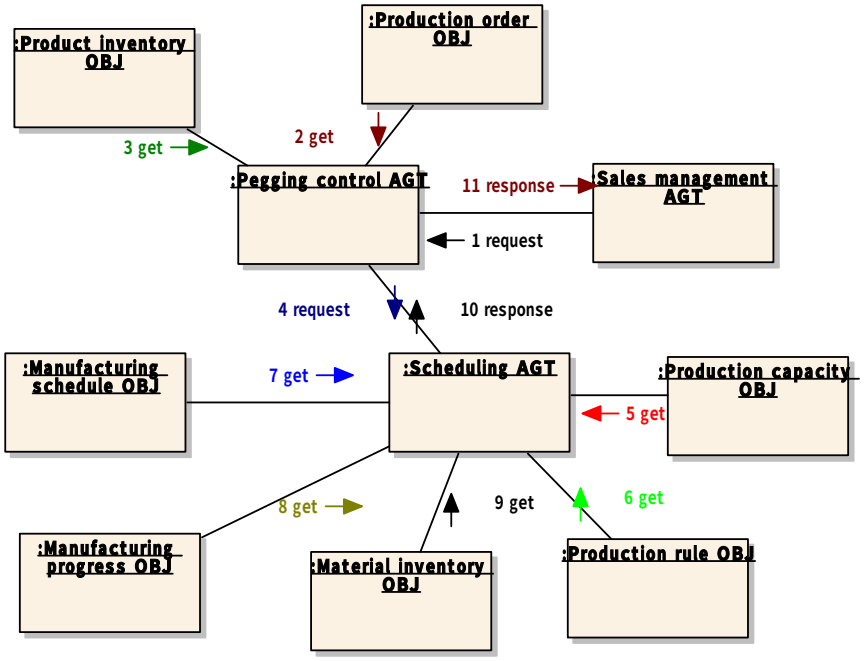

Figure 9　Due Date Estimation Collaboration

✧ Manufacturing execution collaboration (5)

This collaboration follows the manufacturing indication and actually executes manufacturing with issuing the manufacturing indication information to every facility or every machine.　After executing manufacturing, this collaboration gathers manufacturing progress and operation progress and these results are reflected to the later plan and indication.

Name	Manufacturing execution collaboration
Agent	Scheduling agent, Manufacturing execution agent
Object	Manufacturing schedule object, Production capacity object, Production rule object, Material stock object, Manufacturing progress object

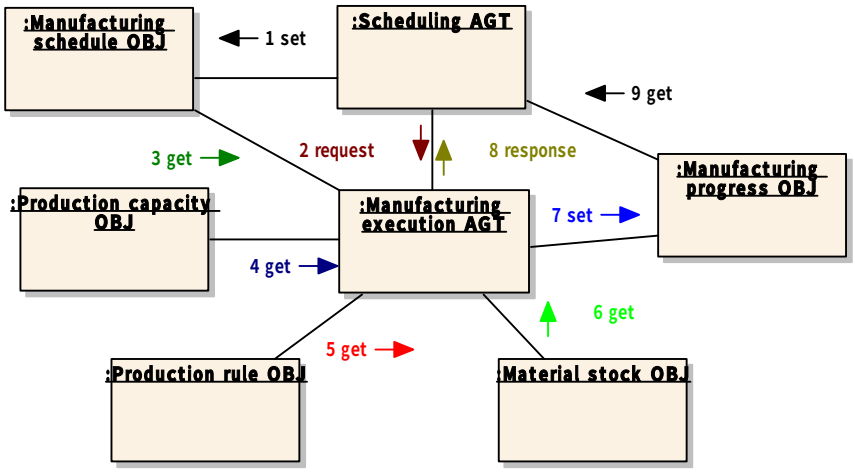

Figure 10　Manufacturing Execution Collaboration

4.2.　Decision-making on Production Resources

When seeing from the viewpoint of production resource that is the producing side, the following collaborations concerned with the capacity or the tolerance value of resource, maintenance and management of those resources are necessary.

✧ **Resource planning collaboration（6）**

This collaboration forms the plan to increase lines and to establish or to abolish factories following a new market tendency.

Name	Resource planning collaboration
Agent	Planning agent, Process design agent
Object	Financial statement object, Market demand object, Production policy object, Supplier object, Production capacity object, Transportation capacity object, Production rule object

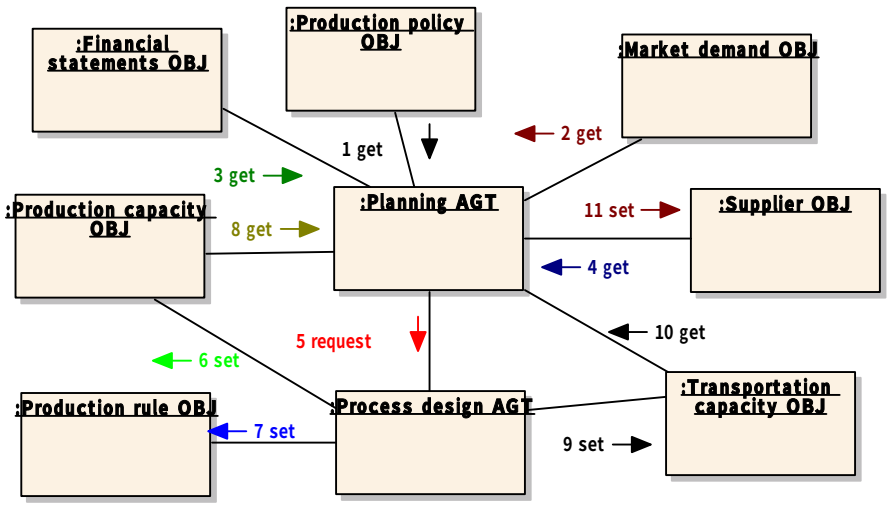

Figure 11　Resource Planning Collaboration

✧ Capacity plan collaboration（7）

The capacity of production resources such as facility or worker is controlled according to a production order.　To put it concretely, this collaboration changes the ability of worker or the capacity of facility. Specifying the operation calendar in every resource controls the ability and the capacity.

Name	Capacity plan collaboration
Agent	Planning agent, Scheduling agent, Capacity control agent, SC management agent
Object	Production order object, Production capacity object, Manufacturing schedule object

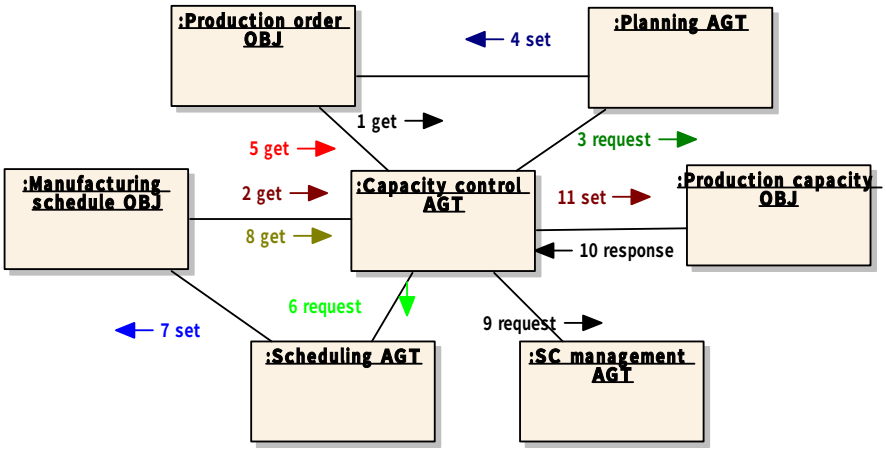

Figure 1-12　Capacity Plan Collaboration

✧ Facilities maintenance collaboration（8）

This collaboration specifies a plan for facilities maintenance. Facilities maintenance is necessary irregularly and executed by cutting into the production schedule.　Facilities maintenance monitors the operation conditions of various facilities and specifies a plan if necessary.

Name	Facilities maintenance collaboration
Agent	Facilities maintenance agent, Scheduling agent
Object	Production order object, Manufacturing schedule object, Production capacity object, Maintenance instruction object, Production rule object, Production policy object

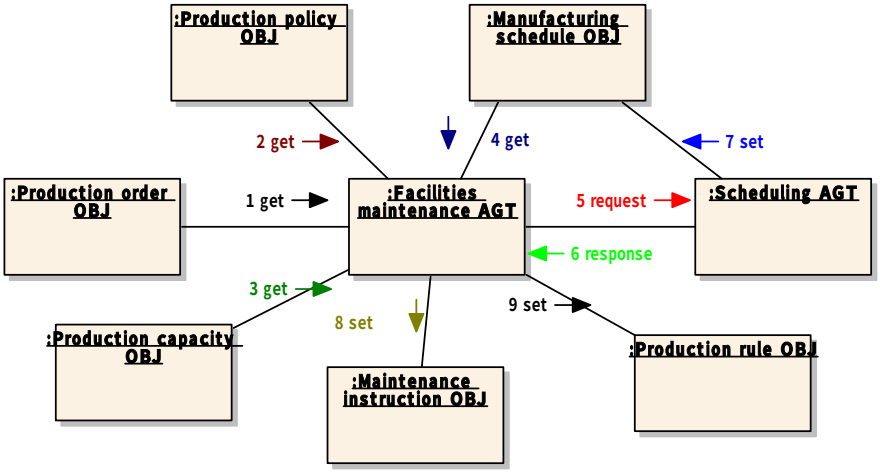

Figure 13　Facilities maintenance Collaboration

4.3.　Decision-making on Supply Chain

From the viewpoint of the entire supply chain, it is important that how the relation with customer and the relation with outside enterprises such as suppliers are constructed.　These are concretely handled as the following collaborations about sales activities for product or material supply.

✧ **Sales plan collaboration（9）**

Sales section creates a sales plan based on the original forecasting. The created plan is the sales target for a creator.　This information is used for production order planning.

Name	Sales plan collaboration
Agent	Order management agent, Planning agent
Object	Production order object, Production policy object, Customer order object, Market demand object, Sales plan object, Product inventory object

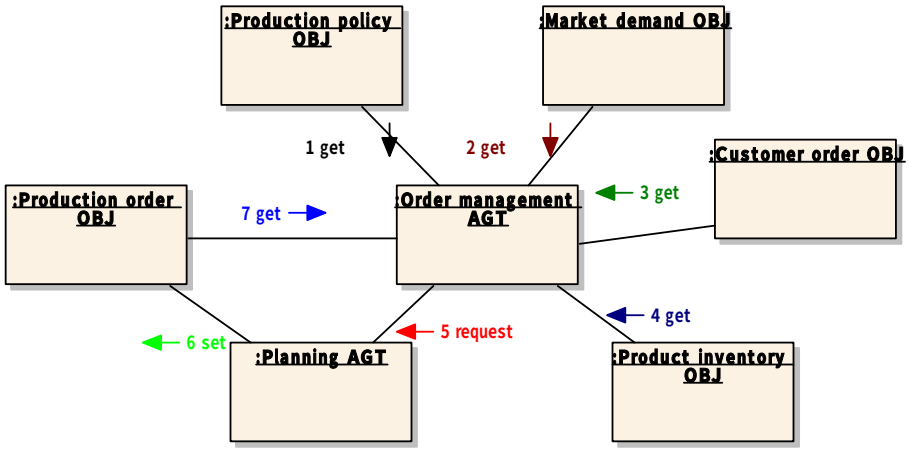

Figure 14　Sales Plan Collaboration

✧ Stock plan collaboration（10）

This collaboration controls the proper level to keep the fixed amount of the finished product stock for providing for the future demand.　In this collaboration, not only the finished product inventory in a factory but also the finished product inventory in the distribution process is considered.

Name	Stock plan collaboration
Agent	Stock control agent, SC management agent, Planning agent
Object	Stock plan object, Product inventory object, Sales plan object, Production order object, Transportation schedule object

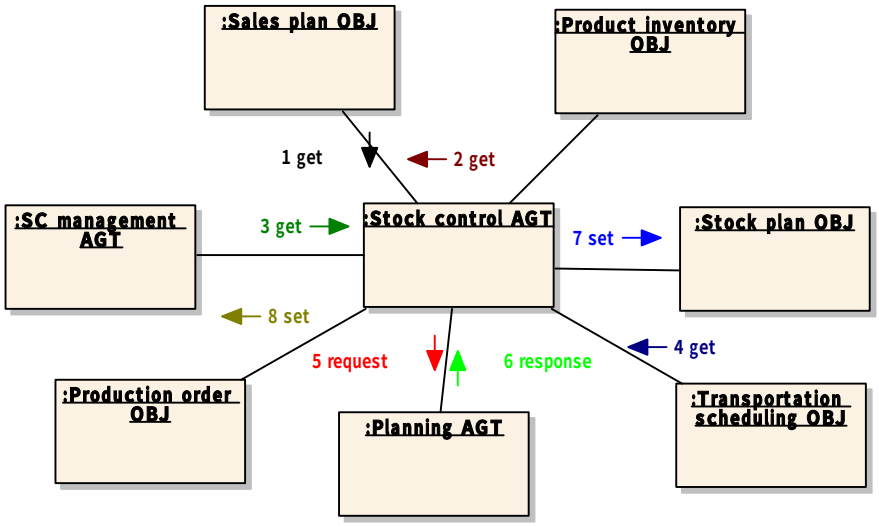

Figure 15　Stock Plan Collaboration

✧ Supplier management collaboration（11）

This collaboration selects a supplier and decides the content of contract to efficiently supply the necessary material with a profitable condition. This collaboration includes the case where the specific process besides materials is supplied by outsourcing.

Name	Supplier management collaboration
Agent	SC management agent, Planning agent, BOM management agent
Object	Production policy object, Production order object, Supplier object, Production capacity object

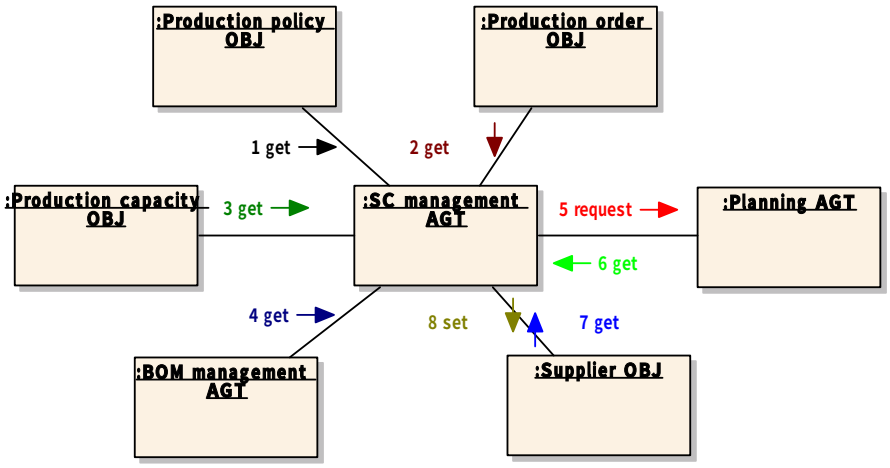

Figure 16　Supplier Management Collaboration

✧ Purchase plan collaboration（12）

Purchase plan is made in advance for the purpose that the materials required for production can be supplied at all times.

Name	Purchase plan collaboration
Agent	Purchase plan agent
Object	Manufacturing schedule object, Purchase order object, Material stock object, Production order object, Supplier object

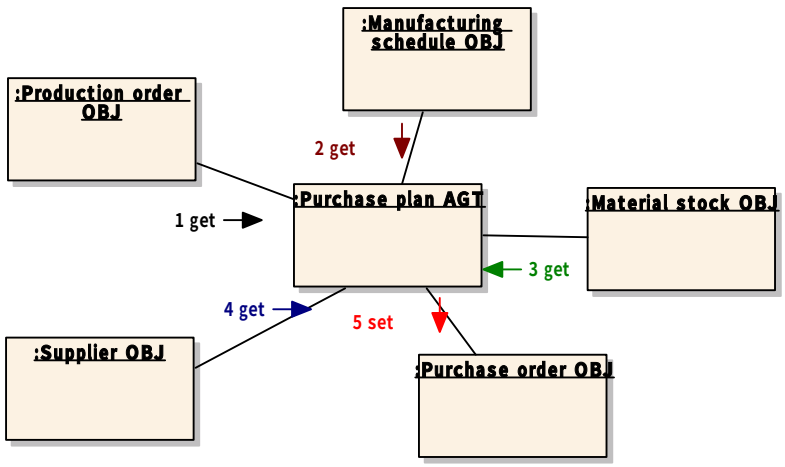

Figure 17　Purchase Plan Collaboration

✧ Transportation schedule collaboration（13）

This collaboration specifies the transportation schedule by synchronizing with production schedule. This collaboration specifies schedule such as conveyance between the processes in two separated places or transportation between bases. And also it selects the best transportation route.

Name	Transportation schedule collaboration
Agent	Transportation management agent, SC management agent, Planning agent, Scheduling agent
Object	Transportation schedule object, Transportation capacity object, Supplier object, Production order object

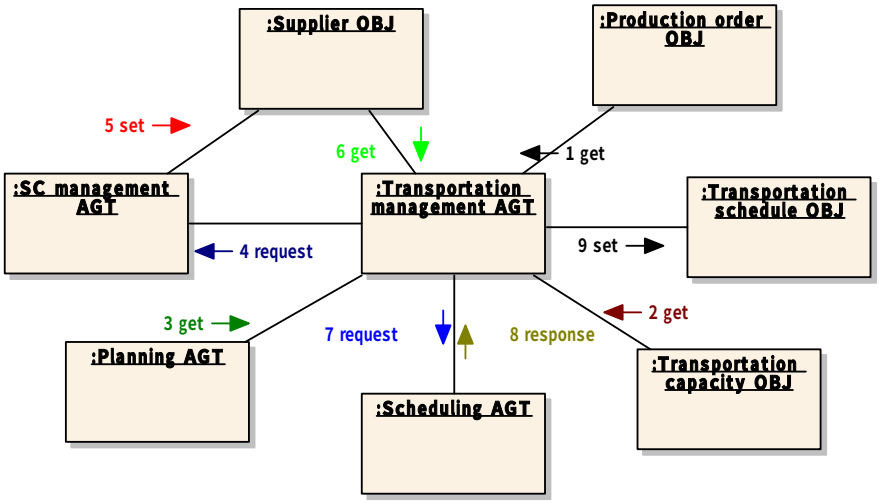

Figure 18 Transportation Schedule Collaboration

5. APS Expansion Collaboration Models

As seeing the basic configuration of collaboration shown in Chapter４, each collaboration in APS is not independent and relates with each other. Because the agents and the objects constructing collaboration are common and they influence each other in the process of collaboration.

It is possible to design APS's own mechanism with considering this point and combining the basic collaborations shown in Chapter 4. This chapter introduces a new system integrating some collaborations as an example of the specific mechanism in APS. These systems become sketches to concretely realize the integration and the link of Planning and Scheduling that are the basic concepts of APS.

5.1. Booking-type Production System

Booking-type production system is the mechanism for controlling supply and demand with collaborating a sales section and a manufacturing section. Production limit information as a production seat list is used as a medium of information transmission between sales section and manufacturing section. So the sales section can answer and promise the due time and the manufacturing section can execute the balanced production. When a person in charge of sales specifies the reservation for the reliable expected order information in the production seat list, the extremely precise forecasting is available.

Booking-type production system mainly consists of three collaborations: “capacity production seat creation,” “capacity production seat reservation,” and “capacity production seat modification.”

✧ Capacity production seat creation collaboration（１４）

Booking-type production system creates a seat at first. Production seat is created in the form for the production order made by planning agent under sales plan or production policy.

Name	Capacity production seat creation collaboration
Agent	Planning agent, Scheduling agent
Object	Sales plan object, Production policy object, Production order object, Manufacturing schedule object, Production rule object, Production capacity object, Material stock object

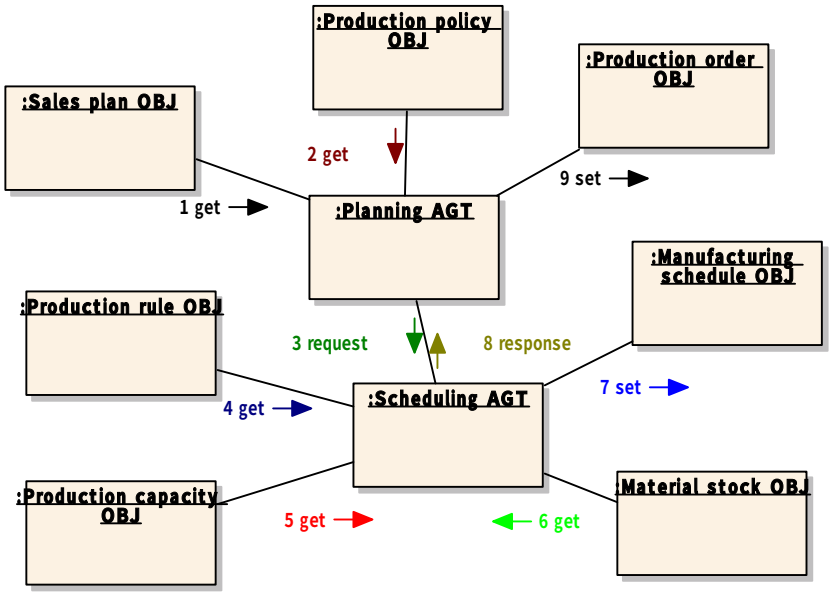

Figure 19　Capacity Production Seat Creation Collaboration

✧ Capacity production seat reservation collaboration（15）

Customer's request is corresponded to the seat list that was specified as a production seat beforehand.　When the applicable seat exists, the seat is reserved as a customer order.　The customer order gotten there is transmitted to a production field as a manufacturing indication with guaranteeing the due time.

Name	Capacity production seat reservation collaboration
Agent	Order management agent, Scheduling agent
Object	Market demand object, Production order object, Manufacturing schedule object, Customer order object

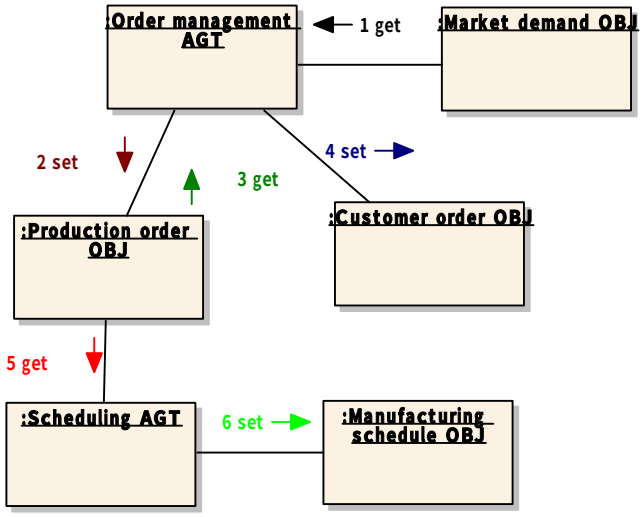

Figure 20　Capacity Production Seat Reservation Collaboration

✧ Capacity production seat modification collaboration（16）

When there is no production seat corresponding to a customer request, a new seat is recreated to apply to the request if necessary.　In such a case, rescheduling is executed with a prerequisite that the due time and the amount of products are sure to be satisfied for the already reserved production seat.

Name	Capacity production seat modification collaboration
Agent	Order management agent, Scheduling agent, Planning agent
Object	Market demand object, Production order object, Manufacturing schedule object, Production rule object, Production capacity object, Material stock object

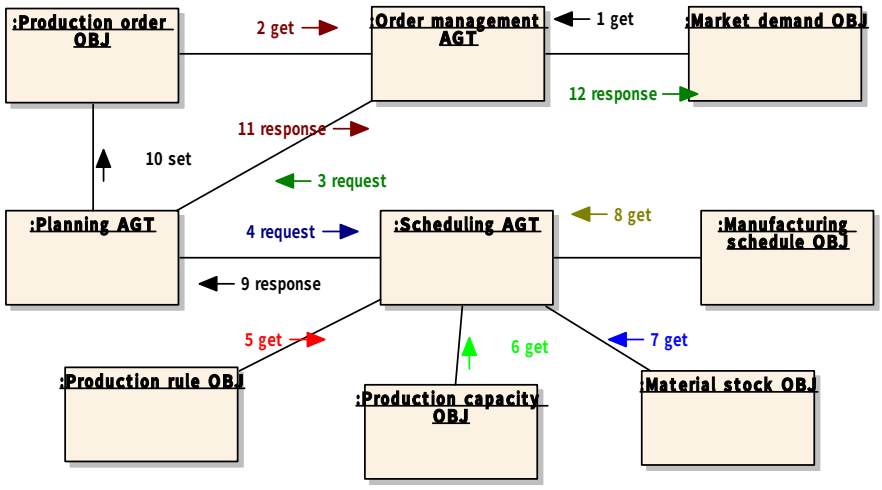

Figure 21 Capacity Production Seat Modification Collaboration

5.2. Mixed Production and Order Allocation System

Mixed production allocation system doesn't tell speculative production and build-to-order production as usual and manages all items after the mixed method of combining speculative production and build-to-order production. If an order isn't received to the end, the production is close to speculative production. If an order is received immediately after planning, the production is close to build-to-order production. In short, this system is the system in which the management method seems to change dynamically for every item according to the condition of order. Speculative production lot and build-to-order production lot are mixed and run in individual processes. This system has a special feature that is able to execute lead-time shortening and inventory reduction at the same time.

Mixed production and order allocation system mainly consists of three collaborations: "mixed production plan generation," "planned order allocation," "plan revising by progress."

✧ Mixed production plan generation collaboration (17)

In mixed production and order allocation system, a production order is specified beforehand as a plan order according to forecasting. Manufacturing schedule in each process immediately develops the production order. And materials are supplied if necessary.

Name	Mixed production plan generation collaboration
Agent	Planning agent, Scheduling agent
Object	Market demand object, Production policy object, Sales plan object, Production capacity object, Production order object, Manufacturing schedule object, Production rule object, Material stock object

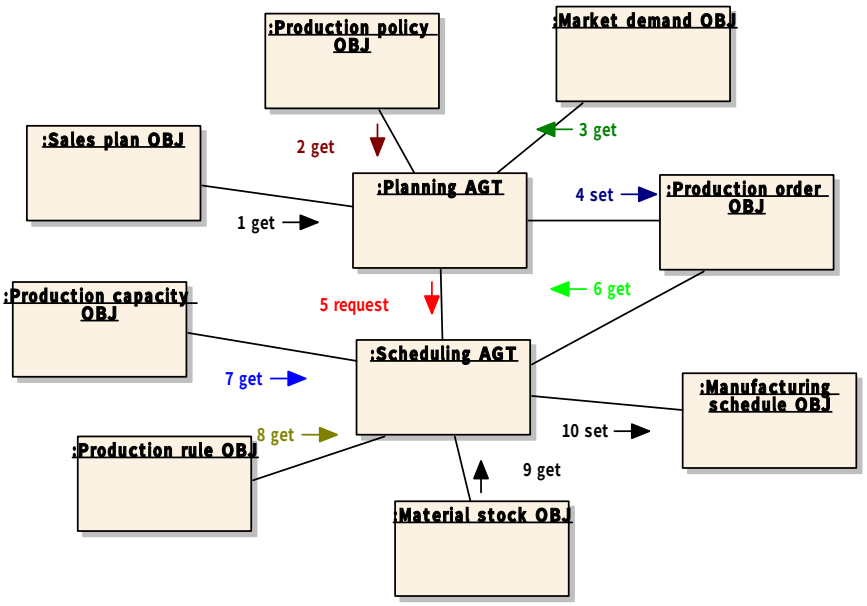

Figure 22　Mixed Production Plan Generation Collaboration

✧ Planed order allocation collaboration（18）

When receiving the actual customer order, this collaboration allocates the applicable production order and the detailed manufacturing schedule to the order.　Even if producing is completed and the products are in stock, this collaboration allocates them for the completed plan information.　This allocation considers fractions and the difference of lot sizes.

Name	Planed order allocation collaboration
Agent	Planning agent, Pegging control agent
Object	Customer order object, Production order object, Manufacturing progress object, Manufacturing schedule object

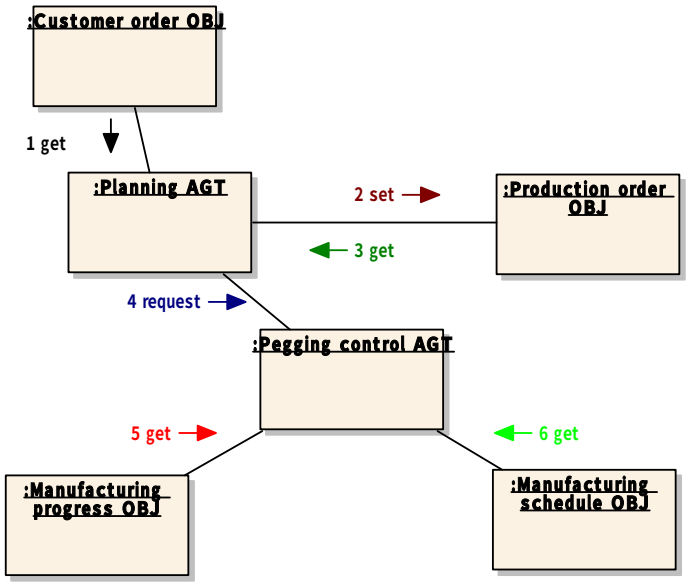

Figure 23　Planed Order Allocation Collaboration

✧ Plan revising by progress collaboration（19）

Whenever individual manufacturing schedule is executed under the daily production progress, plan revising by progress collaboration grasps the progress information and reflects it on the production order information finally.

Name	Plan revising by progress collaboration
Agent	Pegging control agent, Manufacturing execution agent, BOM management agent
Object	Production order object, Manufacturing schedule object, Material stock object, Manufacturing progress object, Product inventory object

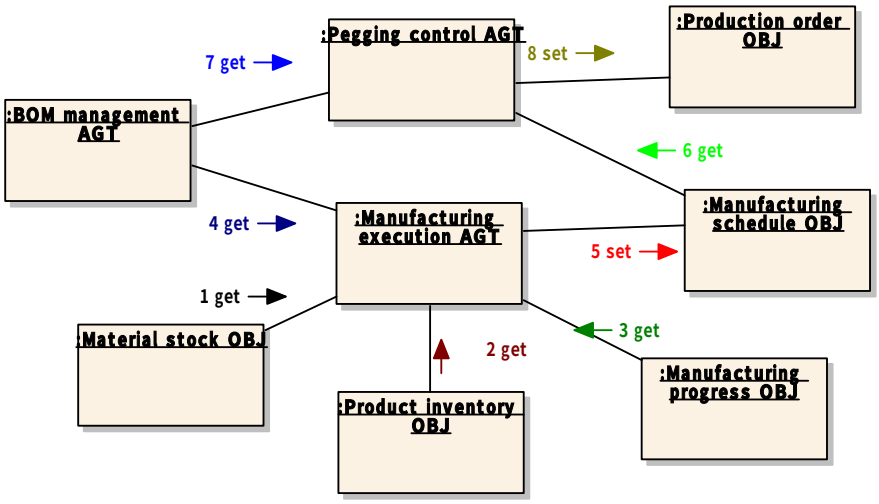

Figure 24　Plan Revising by Progress Collaboration

5.3.　Collaborative Option Decision System

Collaborative specification decision system is the mechanism for starting to make the parts of which the specification is defined when starting to produce before the specification is decided completely in individual build-to-order production.　And at the same time, the system manages the schedule where the business section must decide the specification with a customer by the last due date.　It is possible to produce the product suited to individual customer's specification in the shorter lead-time.

Collaborative option decision system consists of three collaborations: "preliminary order entry," "option data decision request," and "additional option data entry."

✧ Preliminary order entry collaboration（２０）

In preliminary order entry collaboration, the customer order of which specification isn't settled yet is accepted and processed as a regular order.　The unsettled specification is notified to option control agent.

Name	Preliminary order entry collaboration
Agent	Order management agent, BOM management agent, Pegging control agent, Option control agent
Object	Customer order object, Manufacturing schedule object

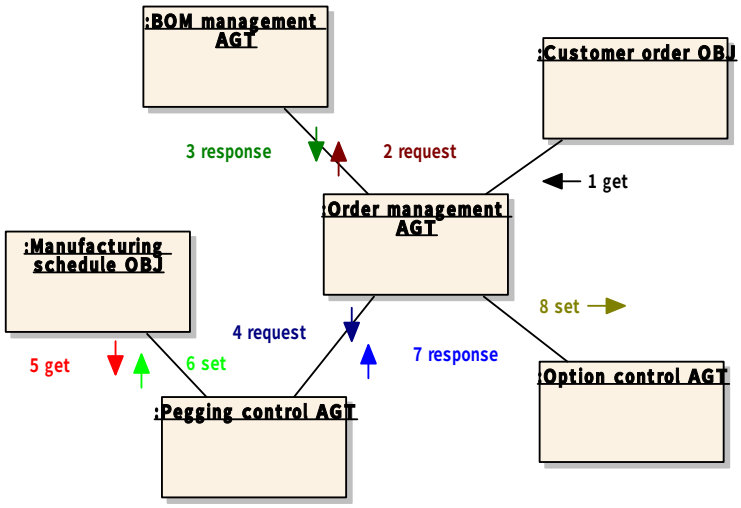

Figure 25　Preliminary Order Entry Collaboration

✧ Option data decision request collaboration（21）

Option data decision request collaboration provides the information about the latest option decision date indicating the time when the unsettled option must be decided in order to keep the due date required by a customer and requests the customer to decide the specification.

Name	Option data decision request collaboration
Agent	Option control agent, BOM management agent, Scheduling agent, Order management agent
Object	Customer order object, Production capacity object, Manufacturing progress object, Manufacturing schedule object, Material stock object

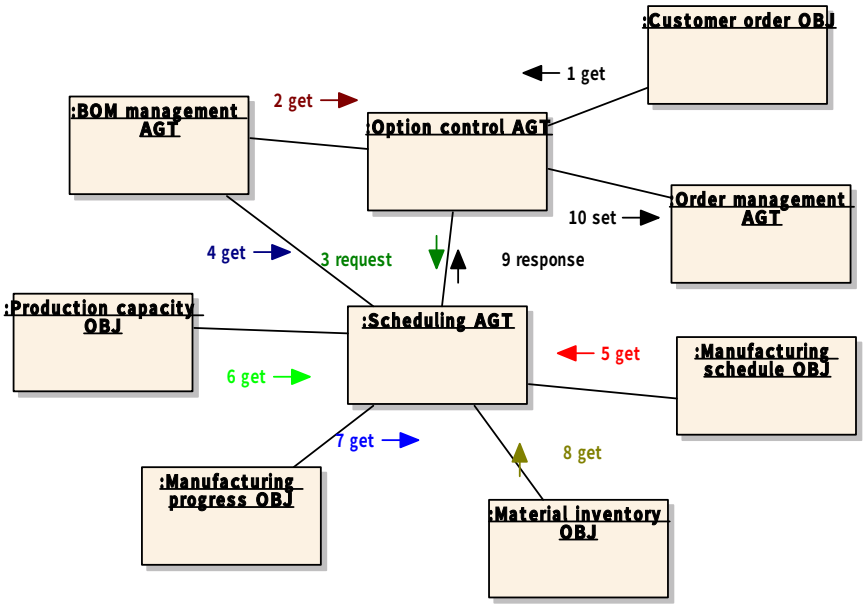

Figure 26　Option Data Decision Request Collaboration

✧ Additional option data entry collaboration（2 2）

When the customer's specification is decided additionally, additional option data entry collaboration reflects the information to sales BOM and creates and sends the necessary instruction information to the production field at the same time.

Name	Additional option data entry collaboration
Agent	Option control agent, Order management agent, BOM management agent, Pegging control agent
Object	Manufacturing schedule object, Customer order object

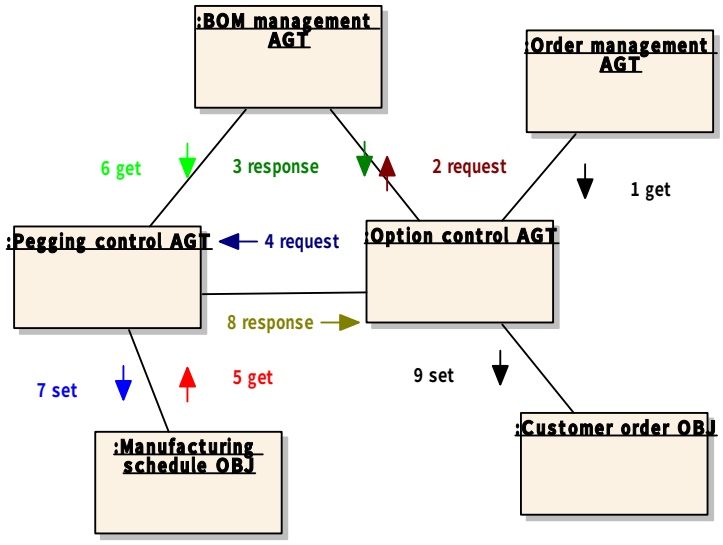

Figure 27　Additional Option Data Entry Collaboration

5.4.　Project-oriented Batch Production System

The former project-type production was the typical one-item production including design development process.　Project-oriented batch production system is the method that the fixed amount of products is produced repeatedly for the fixed period and the production is stopped by itself according to the product lifecycle.　This production anticipates the change of customer's desire and has the effect to maximize the cash flow.

Project-oriented batch production system consists of three collaborations: “cash flow management,” “model change scheduling,” and “model change execution.”

✧ Cash flow management collaboration（2 3）

In cash flow management collaboration, the new product development is regarded as one project and the profits of the entire company are planed with grasping the cost rightly.　In this collaboration, product design, process design and the sales section decide the basic plans under the indicator such as profitableness.

Name	Cash flow management collaboration
Agent	Planning agent, Cost control agent, Product design agent, Process design agent, Policy management agent
Object	Financial statement object, Production policy object, Sales plan object, Production order object

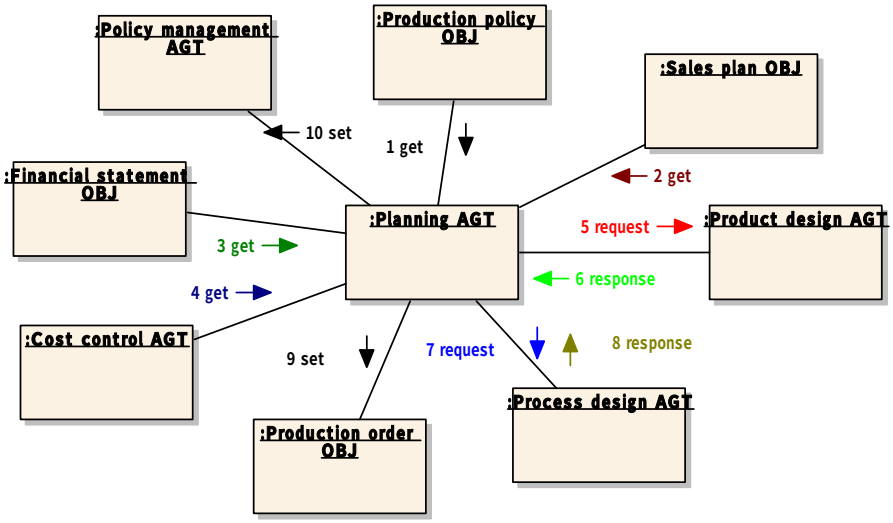

Figure 28　Cash Flow Management Collaboration

✧ Model change scheduling collaboration（2 4）

Once mass production starts and the product shipping starts, it is important to make the decision on how long the product will continue being produced.　Model change scheduling collaboration decides the timing to close production and to switch to new product manufacturing.

Name	Model change scheduling collaboration
Agent	Scheduling agent, Cost control agent, Pegging control agent
Object	Sales plan object, Customer order object, Production order object, Manufacturing schedule object, Purchase order object, Material stock object, Manufacturing progress object, Stock plan object, Product inventory object

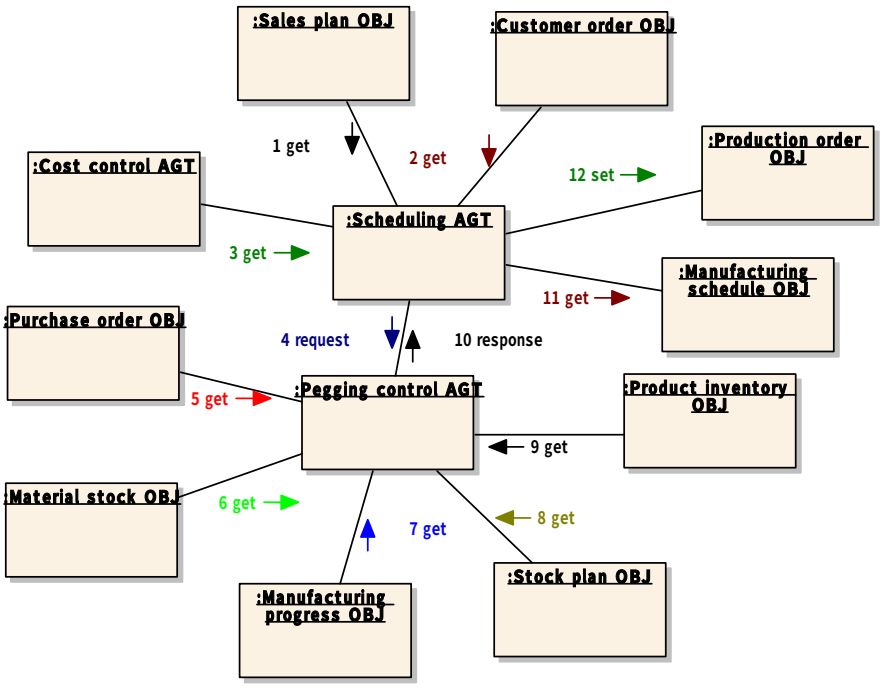

Figure 29　Model Change Scheduling Collaboration

✧ Model change execution collaboration（25）

When changing a model of product, this collaboration manages the timing to switch the present model production to the new model production in every process and changes the model at the timing with the least waste.

Name	Model change execution collaboration
Agent	Scheduling agent, BOM management agent, Pegging control agent, Process design agent
Object	Production order object, Manufacturing progress object, Manufacturing schedule object

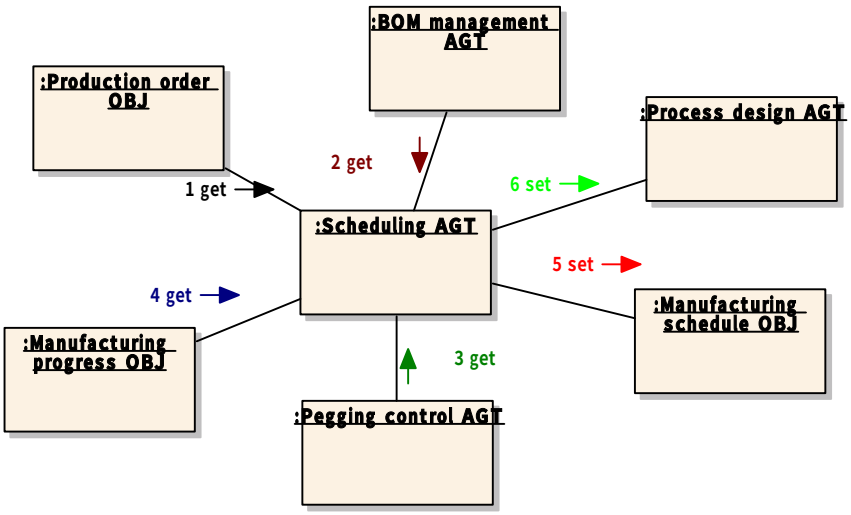

Figure 30　Model Change Execution Collaboration

6. Planning/Scheduling Federation Planning in Multi-site in APS

Multi-site federation planning is the mechanism to dynamically link business processes in each site by showing the plan information each other by APS systems scattering in each site and by keeping data matching as a whole. This federation enables inventory reduction and lead-time shortening by linking with the related client factory or linking transportation process with production process.

6.1. Sharing Production Capacity And Inventory Information

The inventory information and the information on production capacity are shared between partnered enterprises. Thus materials can be ordered or one part of process can be executed by outsourcing with considering the partner's conditions. At the same time, the supply lead-time becomes more exact.

✧ **Decision by Inventory information sharing collaboration（26）**

Name	Decision by inventory information sharing collaboration
Agent	Scheduling agent, Purchase plan agent, Federation management agent, Order management agent
Object	Purchase order object, Production capacity object, Product inventory object, Customer order object

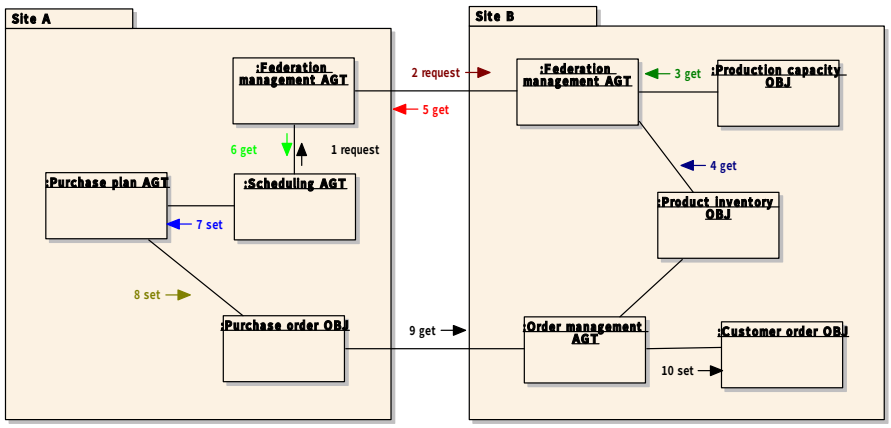

Figure 31　Decision by Inventory Information Sharing Collaboration

6.2.　Sharing Production Plan And Forecasting information

The basic information of each enterprise for production plan such as forecasting or the expected sales is shared.　Thus the production plan with the higher precision can be created between supply chains.　This may be the realization of CPFR（Collaborative Planning, Forecasting and Replenishment）by APS.

✧ Demand forecast sharing collaboration（27）

Name	Demand forecast sharing collaboration
Agent	Planning agent, Federation management agent
Object	Market demand object, Sales plan object, Stock plan object, Production order object

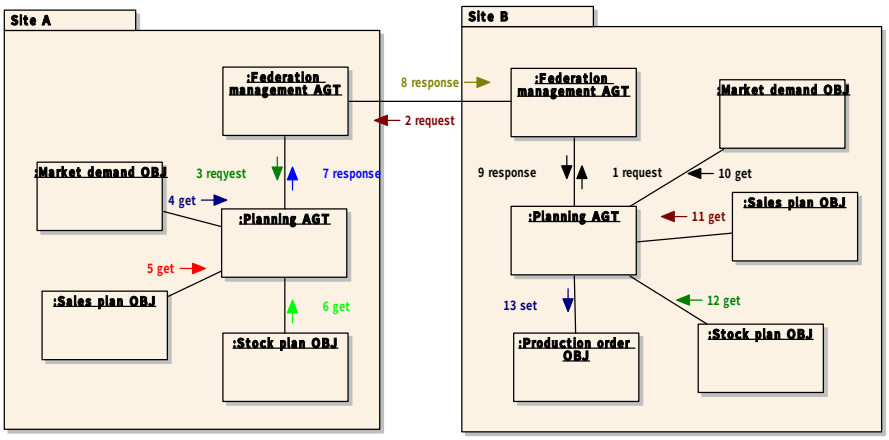

Figure 32 Demand Forecast Sharing Collaboration

6.3. Sharing And Linking Production Order Plan Information

The information is sharing between enterprises on the production order plan level. Therefore the plans link between different enterprises as if they belonged to the same enterprise.

✧ **Production plan sharing collaboration（2 8）**

Name	Production plan sharing collaboration
Agent	Planning agent, Scheduling agent, Federation management agent
Object	Product inventory object, Production order object

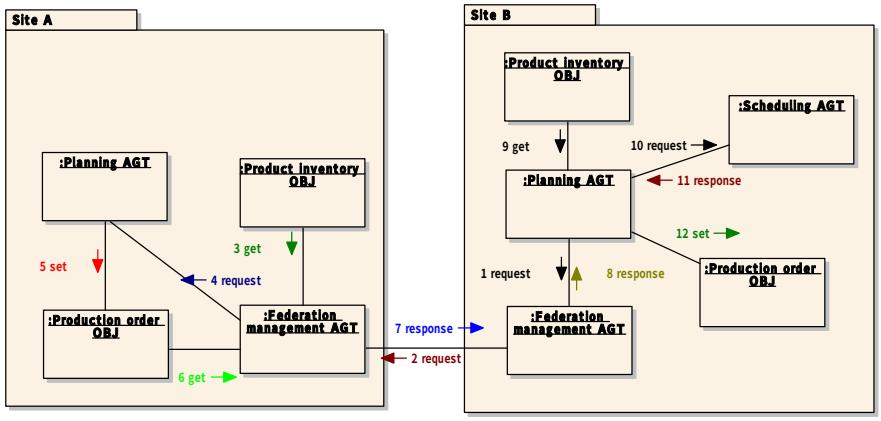

Figure 33 Production Plan Sharing Collaboration

6.4. Synchronous Production on Production Instruction Level

The actions for each production synchronize on the production instruction level such as manufacturing schedule. The closer linkage between enterprises can be realized. It is possible to synchronize not only two production processes but also with transportation process by linking with 3PL enterprise or distribution enterprises.

✧ **Production instruction sharing collaboration（2 9）**

Name	Production instruction sharing collaboration
Agent	Scheduling agent, Federation management agent
Object	Transportation schedule object, Material stock object, Production capacity object, Manufacturing schedule object, Manufacturing progress object, Production order object, Production rule object

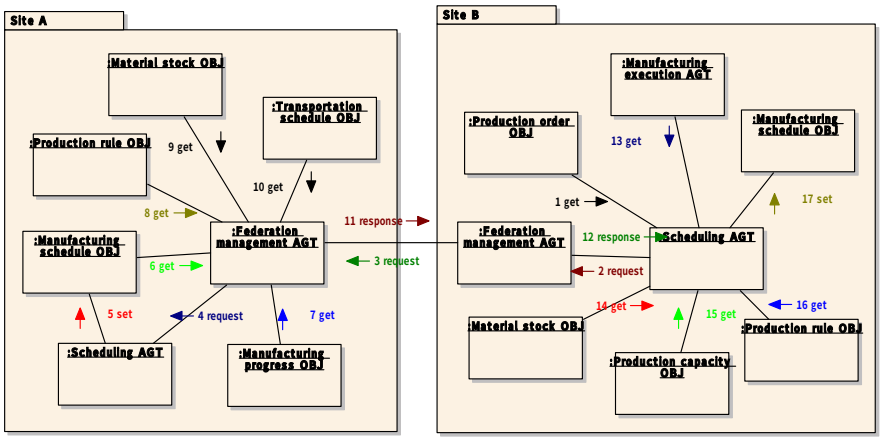

Figure 34　Production Instruction Sharing Collaboration

Appendix A Business Environment of Manufacturing Enterprises

In 1980s, Japanese manufacturing industry was at the height of its prosperity, in 1990s it lost its power and nowadays in 21 century it seems to miss the direction to go. What Japanese manufacturing industry should do first is to start rightly recognizing the business environment where manufacturing enterprises are currently placed. The specific changes in the business environment in recent years are classified into the external factors and the internal factors as follows.

A.1 Change in External Environment

✧ **Over-supply by deflation**

Today is the time when deflation economy continues for a long time and goods are not easy to be sold. The price of goods tends to fall with time. It is very high risk for products to be in stock and so it is the important point for profits that products are sold as soon as the products are made or the products are made without losing an opportunity for selling them.

✧ **Shortening product lifecycle**

The cycle of developing new products becomes short rapidly. Customers aren't satisfied with the minimum function. It is necessary that how rapid products should answer the change in customer's request, or conversely how products should stimulate the potential desire of customer. So it is necessary and essential to continue providing new products repeatedly for the market for creating a new demand.

✧ **Uncertainty of forecasting increases**

In an information-oriented society, a hit goods is sold explosively all of a sudden and is not sold in an instant. The more customer's segment are limited by answering various needs, the more uncertainty of each

product demand increases. The enterprises that can execute the stable production according to forecasting are decreasing.

✧ **Speedup of technological innovation**

The technology is innovated at a very high speed in the high-technology industries such as the industry related with IT. If product development doesn't keep up with the speed of technological innovation, the inferior stocks will be piled up high soon. When a new technology or standards are created, the products made with the former technology or standards will be valueless very rapidly.

✧ **Competition with the low-price product of Chinese enterprise**

Japanese industrial goods were once a synonym for high quality and low-price. But nowadays China and other Asian countries gain power and get able to produce the mass-produced goods whose quality is same as Japanese goods and the price is lower than them. It is clear that Japanese manufacturing enterprises have already no chance of winning in the competition for producing goods at low price. Unless Japanese manufacturing enterprises change the field for competition, they will have a tough game.

✧ **Weight of maintenance and collection service increases**

The role of manufacturing enterprise is not only selling products. If anything, maintenance service after sales or collection service for recycling begin to be the important activities for manufacturing enterprise. Manufacturing enterprise must be concerned in the whole product lifecycle.

✧ **Understanding of environment and safety deepens.**

The measures against environment and safety are taken very seriously as an indicator of evaluating a manufacturing enterprise. Manufacturing enterprises are evaluated with not only the quality of product provided for market but also the quality of enterprise itself severely. The enterprise that doesn't consider safety, like the food industry, will get social sanctions from consumers.

A.2 Change in Internal Environment

✧ **Progress of supplier selection**

Supply chain management has the usual business relations more effectively and moreover expands into supplier selection. Many manufacturing enterprises begin to change their principles from the viewpoint of live-and-let-live to the law of the survival of the fittest. In such a principle, the usual indicator, like quality, cost, due date and besides the rate of progressing IT in a company are regarded as important.

✧ **Direct hit of demand change by integrating vertically**

In case of consumer products, generally the products shipped from factory pass through the various distribution routes to a final customer. The first wholesale dealer and the secondary wholesale dealer, who have shouldered the complex Japanese distributive machinery, are gradually disappearing because major volume sales stores and manufacturing retail stores appear. But the control function for supply and demand balance taken by the usual distribution machinery disappears at the same time. So manufacturing enterprises get directly suffered the hardship of fluctuation in demand.

✧ **Making a little lot and high frequency**

Manufacturing enterprises can't mass-produce as before because of answering the various needs of customer and the unforeseeable change in demand. The idea of just in time, which makes the required amount, the required number of products at the required time, spreads through all sorts of industries. Therefore not only manufacture lot size but also the content of order between enterprises are made in the more little lot and more frequently.

✧ **Dividing functions and getting fabless**

Manufacturing enterprises begin to divide organizations into every function so as to avoid being a big and stiff enterprise. If the enterprise specializes its core competence and displays the engineering ability as one functional element in a virtual corporation, it is the great

advantage to answer the needs more quickly. The case where an enterprise without a manufacturing factory such as a fabless enterprise makes a profit is increasing.

✧ **Supply and production in the best suited place**

Global production is advanced and so all areas in the world become manufacturing fields. The global enterprises are always very sensitive to the best-suited supply: which area is selected for a supplier, in which area the products are made, and in which area the sales activities are done for consumers. There are many cases where a Japanese parts-maker or a subcontract factory closes down or moves the factory into overseas countries because a business-related enterprise manufactures in the local factory.

✧ **Decrease of skilled workers**

Manufacturing engineering cannot be expressed as logically as a manual. A lot of engineering is difficult to pass down, for instance the technique of an expert. Manufacturing skill of a skilled worker, which was Japanese advantage in manufacturing, is disappearing rapidly because the young persons who will take over the skill run short and the production is mechanized.

✧ **Decline in the will to work by restructuring**

Under the present economic conditions, many managers carry out restructuring with a personnel cut, which has been under taboo up to the present. The lifetime employment system breaks down in reality by betraying employees' allegiance to their companies. The work force of Japanese manufacturing industry of which special feature was diligence has the possibility to greatly change the quality in future.

✧ **Increase of distrust and uneasiness toward IT**

Up to this time, manufacturing enterprises mainly cut down expenses and tended to dismiss the excess personnel with automatizing a production line for the investment in the information system. Most of cases where the usual information system investment is mainly in package don't get the expected results because the project isn't

managed successfully. Manufacturing industry is tied down by worrying about falling behind the information-oriented society and distrust of IT.

Appendix B　How to Decide on Grand Design

This specification aims at providing guidelines or reference models for manufacturing enterprises to settle on a new grand design by themselves.　However the information shown in this specification is just one part of the whole information.　So each enterprise must complete the grand design by originally adding information.

There is not the predefined method as the procedure for making a grand design.　When a manufacturing enterprise decides on a grand design, this section individually argues about the point that each enterprise is related with in common.　Refer to the arguments for making the grand design decided by each enterprise more effective.

✧ **Recognizing environment and enabler of change**

Appendix A of this specification shows the specific environments of manufacturing enterprise.　It is the first step for drawing the grand design to decide how to recognize the present or future business environment.

At the same time, it is necessary to watch the trend of engineering as seeds.　While forecasting exactly the impact on business by spreading high-speed Internet from now on, it is necessary to correctly understand APS as an enabler (a thing which enables to realize) of change and to have the knowledge about the potential and the limits of APS.

The present environment and the meaning of new technology ought to be different altogether for each enterprise.　The recognition shared and argued here will serve as a big ground to the last, when drawing the grand design.

✧ **How to deal with a business model change**

When drawing the grand design, it is important to decide clearly a business model of the enterprise.　However, because of a rapid change in the business environment of these days, the form of a competitively

superior business model is also changing. The business model of the enterprise that has been successful until now doesn't necessarily guarantee to be superior in the future.

Therefore business models of each enterprise must continue changing with time. It is necessary to look for a point of agreement between needs and seeds, and to judge calmly the model which uses the current management resources possessed by each enterprise to the maximum and the period when the resources are valid on a mid- and long-term time axis.

✧ **Constructing stakeholder and indicator**

When a business model is actually operated, it is necessary to prove stakeholders beforehand and to analyze that who has what influence and what influence is expected.

After considering the external factors in such a business model, individually tuning in the argument about structuring the related evaluation is needed in order to make the performance of an enterprise into the maximum. Concrete behavior, such as each action of the enterprise, changes a lot by designing exactly the priority and the subordination of indicator beforehand.

✧ **Selection of business architecture**

As the text describes, businesses of each enterprise can't be done with ignoring the existence of business architecture where each enterprise belongs. Each enterprise can make a decision only within the limits permitted by the business architecture where each enterprise belongs whether the enterprise likes or not.

However fortunately the enterprise can select the business architecture suited to it out of some business architectures. There are many cases where the innovative business model conversion brings a changeover of business architecture.

It is very important to be conscious of the existence of business architecture positively in order to rightly recognize the parameter that the enterprise can control with its own intention.

✧ PSLX as the information system architecture

Information system architecture is the pattern for constructing an information system. As “Guidance” shows, the pattern for constructing the information system proposed by PSLX including the content of this specification has a lot of different points from the usual pattern.

Information system architecture is the method of modeling the data and making permanence of each data that is also the fount of the knowledge for an enterprise, the design thought that regards each application as an active agent and thinks a great deal of the link between those agents to the maximum, and the mechanism that can evolve according to the business process change by regarding an information system as one side of a business model.

As a different construction makes a different building, the more flexible and stubborn information system, which differs from the usual system, are made when advancing the development following the information system architecture proposed by PSLX. For deciding on the grand design, consider this point and carry out the way of thinking that is not bound by the frame of the fixed concept of the former system development.

✧ Designing a business reform program

Even if the direction where enterprise should go or the final goal is in sight, the present condition should never change to such an ideal form in one night. Also it is not guaranteed that an object can be attained by spending money and time. In fact, there are many cases where the process for attaining the object is more important than the goal to be reached.

Therefore, the scenario of business reform is required for the grand design for manufacturing enterprises. The scenario must concretely show the route in the time series when an enterprise goes toward the future from the present. Note that a map showing only the goal point is meaningless.

For example, when introducing APS, fully make preparations, like creating basic data, consciousness reform in the field and training new talented persons and so on. Moreover, it is desired to probe the points reformed for filling the gap between the present condition and an ideal form and to create and execute the reform programming for applying to each point.

Always reconsider the goal that was already specified and modify the grand design itself if needed. Thus it can be said that it is the only one way to a success to repeat the grand design decision, execution and reconsideration of the reform programming in the continuous activities of the enterprise.

Appendix C　Cross Reference

The following lists the passages where the agents and the objects appear in the various collaborations shown in from Chapter 4 to Chapter 6.　In the following list, the number in the corresponding collaboration line is the collaboration number shown when explaining the collaboration.

Table 1　Agent list

No.	Name	Corresponding collaboration
1	Policy management agent	1,23
2	Planning agent	1,2,6,7,9,10,11,13, 14,16,17,18,23,27,28
3	Scheduling agent	2,3,4,5,7,8,13,14,15, 16,17,21,24,25,26,28,29
4	Product design agent	23
5	Process design agent	6,23,25
6	Purchase plan agent	12,26,
7	Order management agent	2,4,9,15,16,20,21,22,26,
8	Cost control agent	23,24
9	SC management agent	1,7,10,11,13
10	Transportation management agent	13
11	Capacity control agent	2,7
12	Stock control agent	10,
13	Manufacturing execution agent	5,19,
14	Facilities maintenance agent	8
15	BOM management agent	11,19,20,21,22,25
16	Option control agent	20,21,22
17	Pegging control agent	4,18,19,20,22,24,25
18	Federation management agent	26,27,28,29

Table 2　Object list

No.	Name	Corresponding collaboration
1	Financial statement object	1,6,23
2	Market demand object	1,2,6,9,15,16,17,27
3	Production policy object	1,2,6,8,9,11,14,17,23
4	Production order object	2,3,4,7,8,9,10,11,12,13,14,15,16, 17,18,19,23,24,25,27,28,29
5	Customer order object	9,15,18,20,21,22,24,26,
6	Purchase order object	12,24,26,
7	Manufacturing schedule object	3,4,5,7,8,12,14,15,16,17,18,19,20, 21,22,24,25,29
8	Sales plan object	9,10,14,17,23,24,27,
9	Stock plan object	2,10,24,27,
10	Transportation schedule object	10,13,29
11	Maintenance instruction object	3,8
12	Supplier object	6,11,12,13
13	Transportation capacity object	6,13
14	Production capacity object	1,3,4,5,6,7,8,11,14,16,17,21,26,29
15	Manufacturing progress object	3,4,5,18,19,21,24,25,29
16	Production rule object	3,4,5,6,8,14,16,17,29
17	Product inventory object	2,4,9,10,19,24,26,28
18	Material stock object	3,4,5,12,14,16,17,19,21,24,29