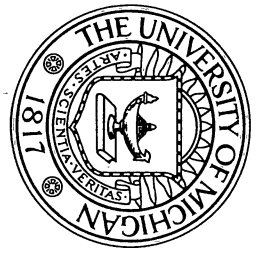
Material procurement and control.

Y. Okayama



UNIVERSITY OF MICHIGAN

SHIPBUILDING SHORT COURSE

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MATERIAL PROCUREMENT AND CONTROL

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CONTENTS

I. FUNCTIONS OF MATERIAL CONTROL

1-1. INFORMATION FLOW AMONG SHIPBUILDING FUNCTIONS

Three distinct material procurement and control functions, namely, material control and requisition, purchasing and subcontracting, and warehousing and palletizing, hold key positions among the shipbuilding functions. Figure 1-1 shows the relations between material control functions and other shipbuilding functions and the information flow among the various functions. Material procurement and control may also be categorized into "control" and "execution" functions. The former category includes material control and requisition which determines scheduling, purchase costs and delivery of the material, and the latter includes purchasing and subcontracting which actually executes the material purchasing from the vendors, and warehouse and palletizing which executes receiving, palletizing and delivery of the materials to the production departments.

1-2. FUNCTIONAL FLOWS

Figures 1-2, 1-3, 1-4, and 1-5 show functional flows of "material control and requisition," "purchasing," "subcontracting," and "warehousing and palletizing." Each flow chart indicates:

- The goal of the function.
- Input data for the jobs of the function.
- Common data filed for the jobs of the function.
- Job description of the function.
- Outputs generated by the jobs.

1-3. ORGANIZATION CHART OF MATERIAL CONTROL FUNCTIONS

Figure 1-6 shows the organization chart and job descriptions of the production control department, which includes specific sections to execute the functions described in 1-1. The purchasing and subcontracting section and the material control and warehouse section are further divided into groups to execute and control the jobs in smaller meshes.

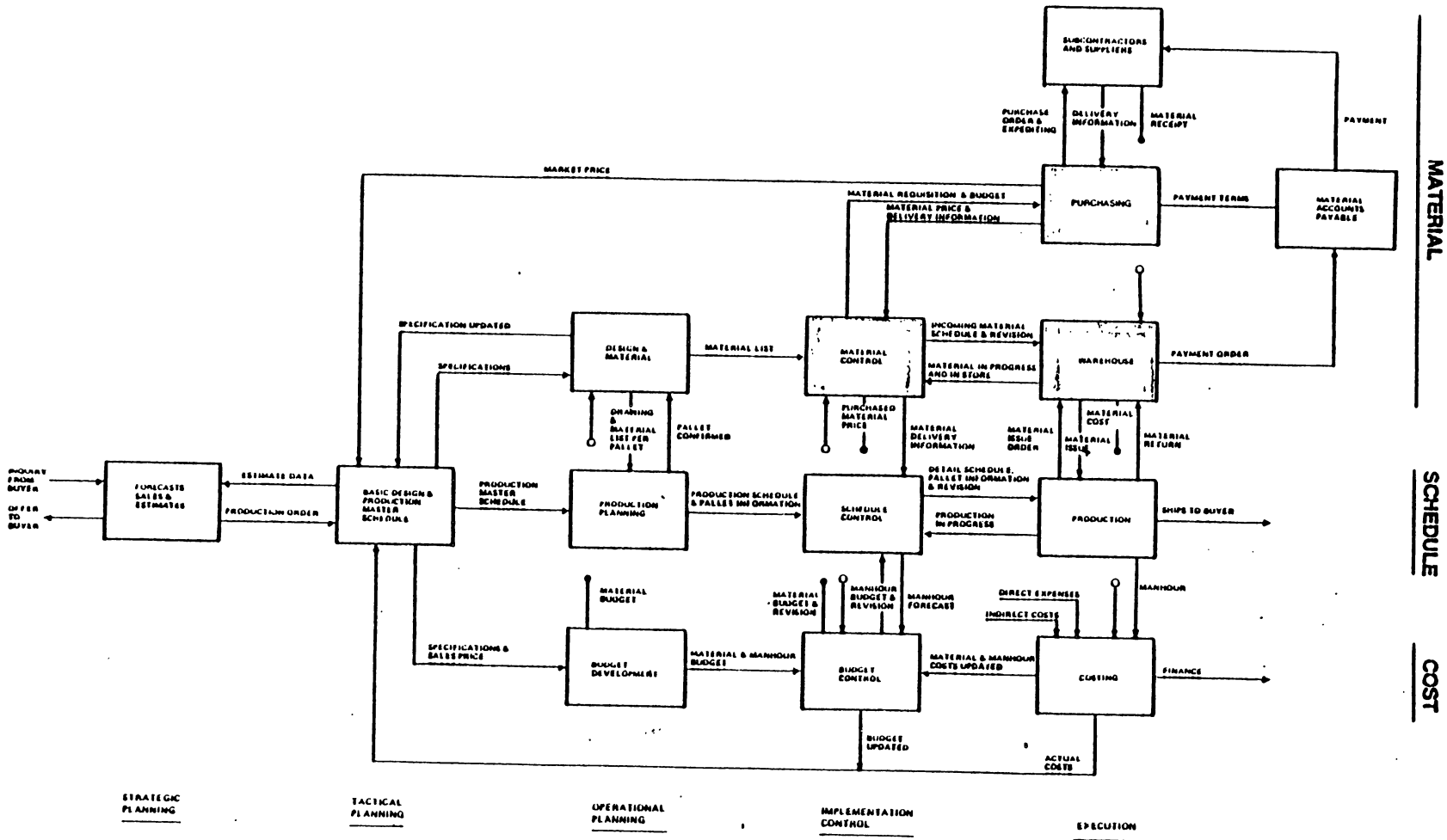


Figure 1-1. Information flow among shipbuilding functions.

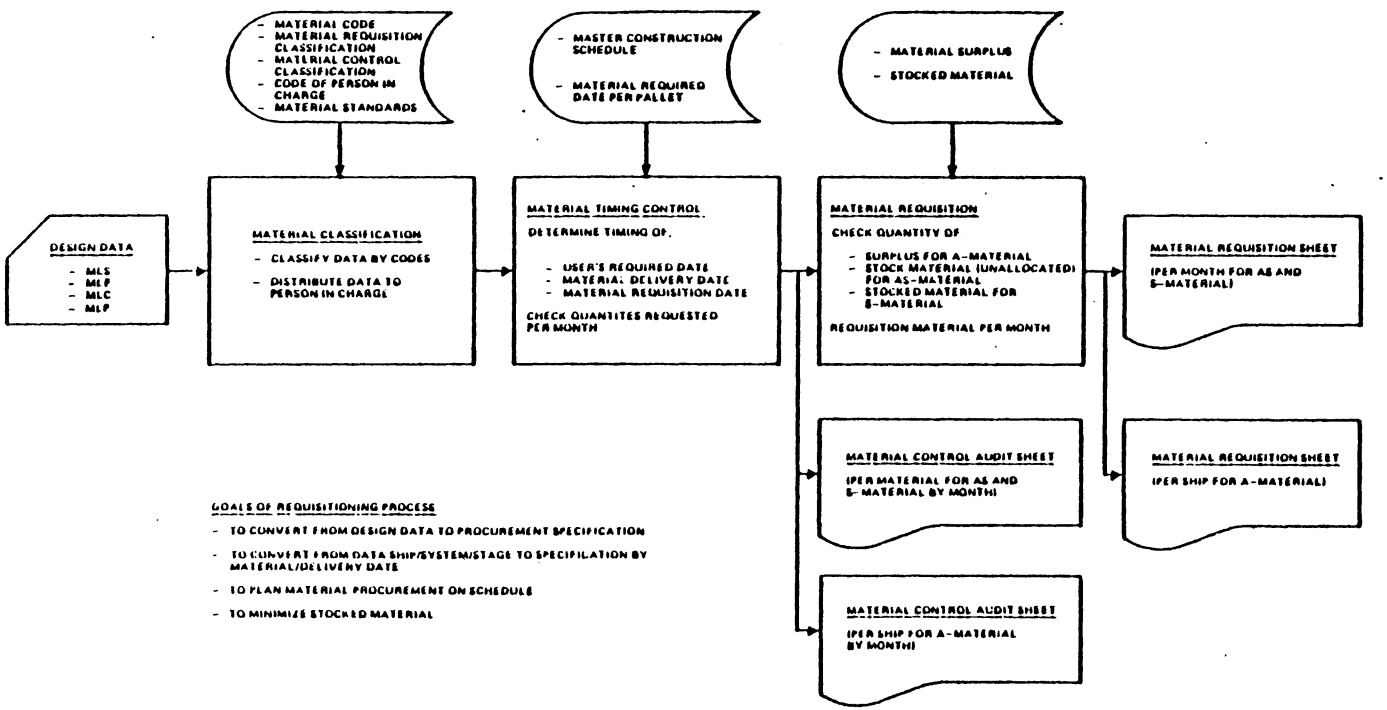


Figure 1-2. Functional flow of the requisition process.

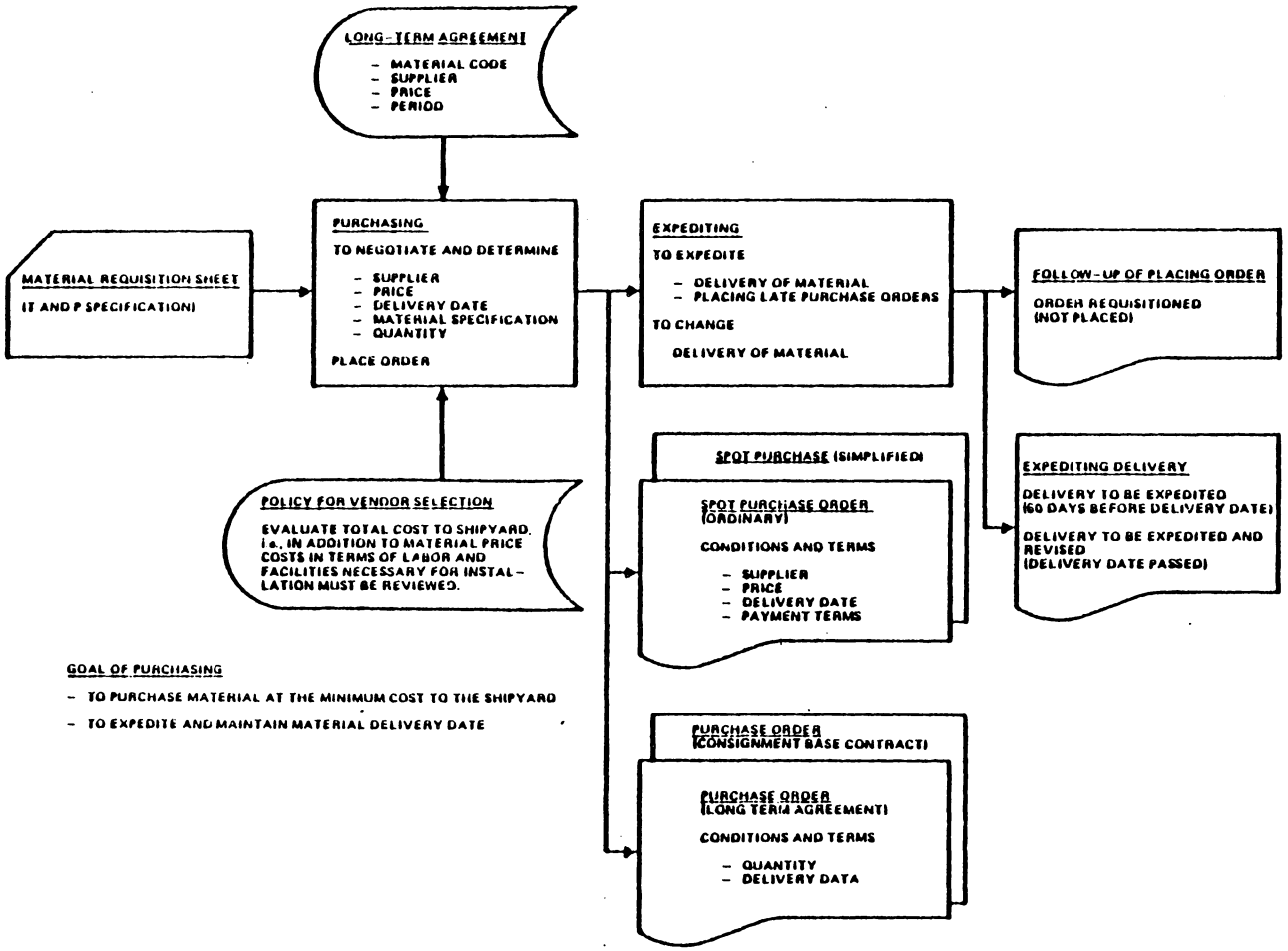


Figure 1-3. Functional flow of the purchasing process.

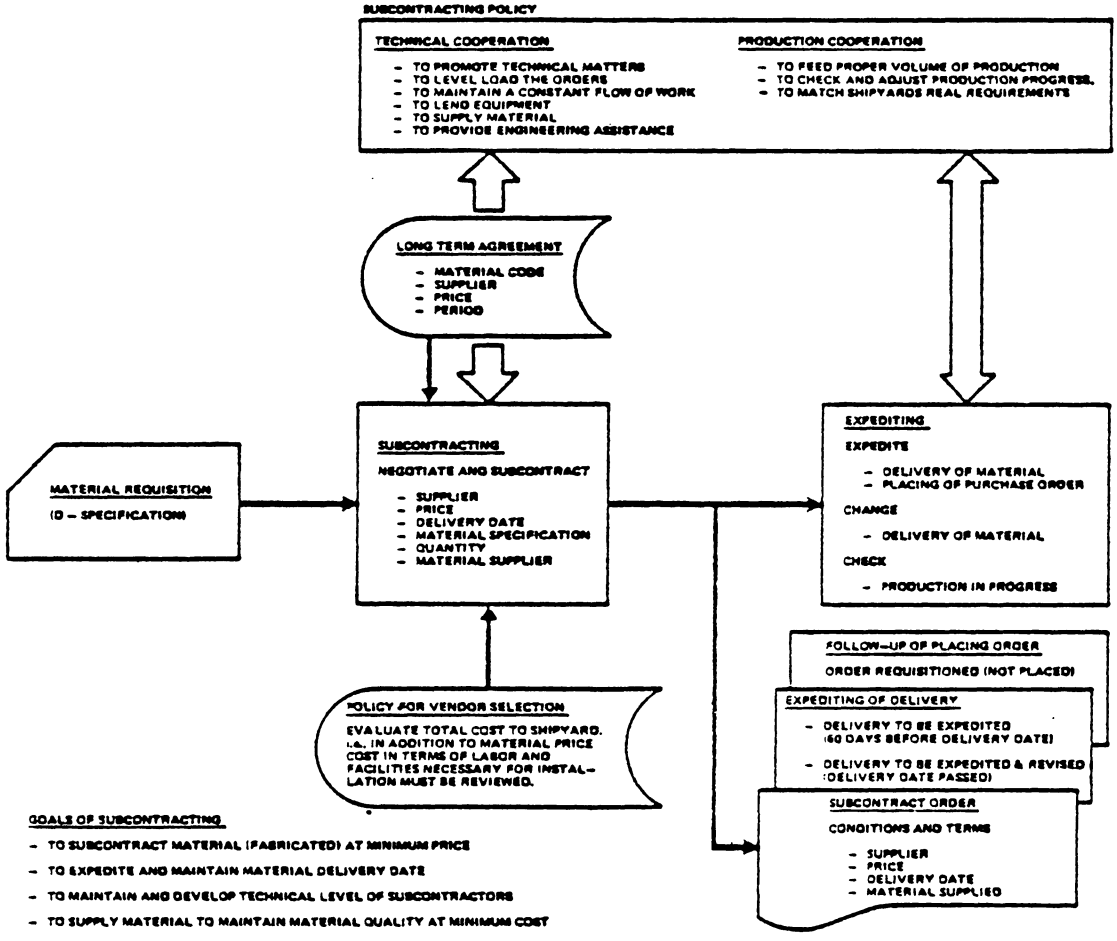


Figure 1-4. Functional flow of the subcontracting process.

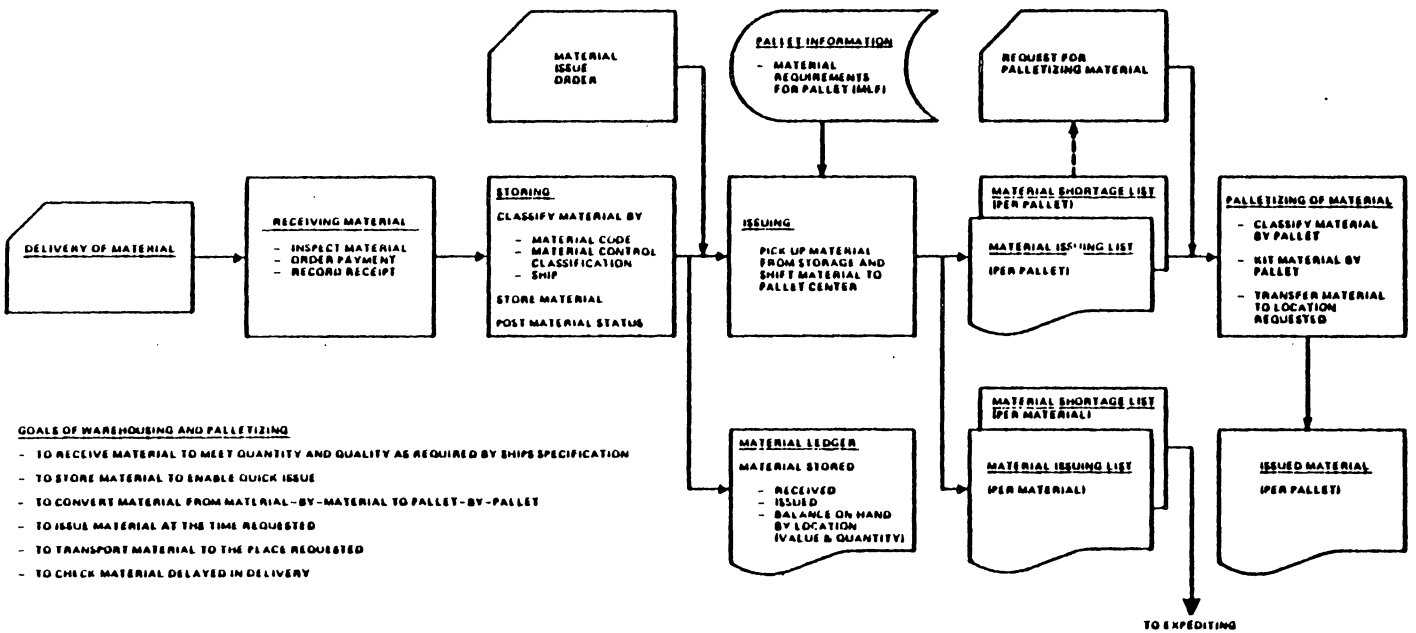


Figure 1-5. Functional flow of the warehouse and palletizing process.

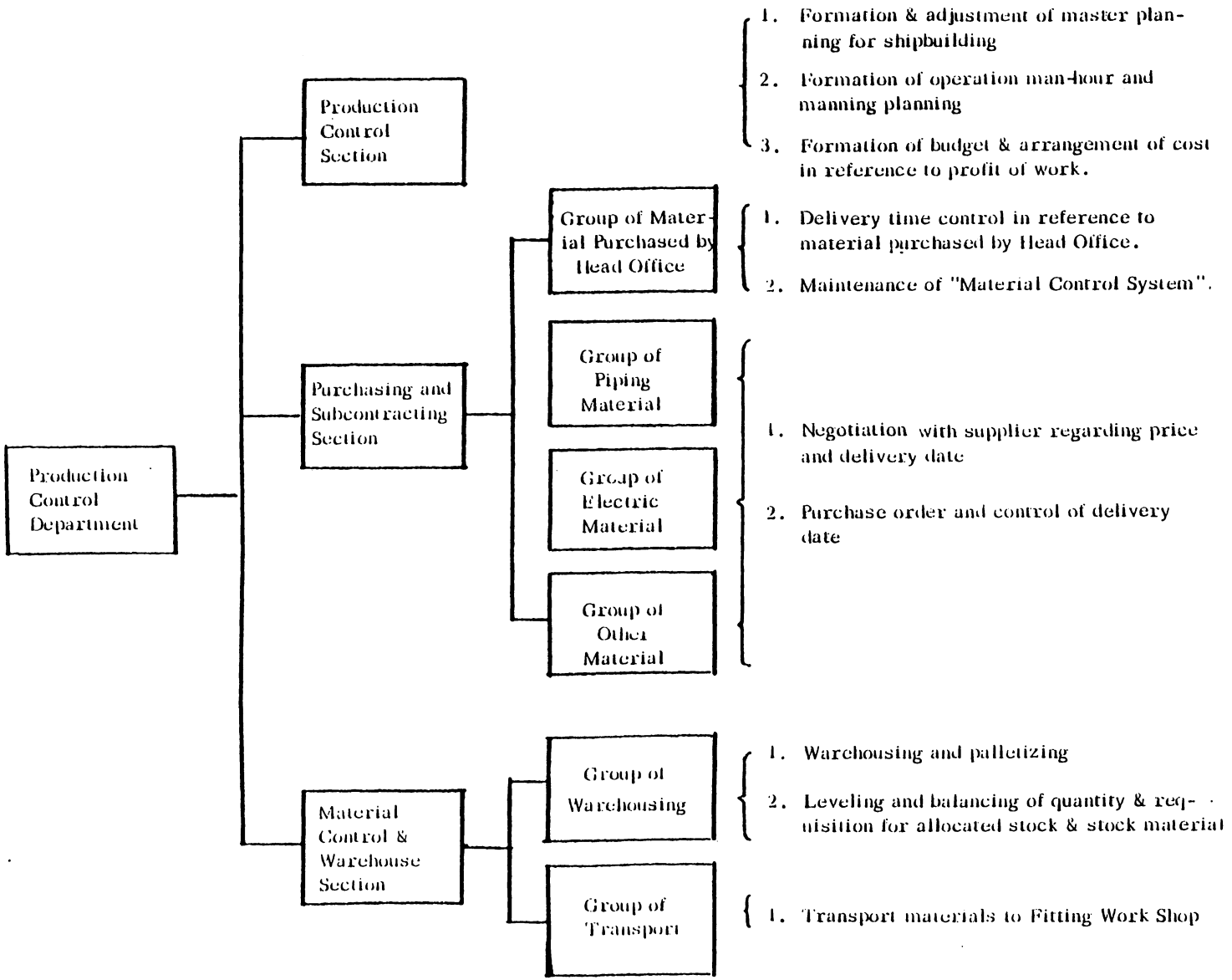


Figure 1-6. Organization chart of the production control department.

II. MATERIAL CONTROL SYSTEM

2-1. CONCEPT OF GROUPING FOR THE MATERIAL CONTROL SYSTEM

In order to maintain high production efficiency and low production cost, classification of various materials should be standardized in the fields of cost estimation, design, material control, warehouse, purchase, and production to suit each function of material procurement. By applying standard classifications, high performance can be maintained in procuring materials.

Furthermore, by starting material procurement with sufficient lead time, the production period could be shortened and the ship could be delivered earlier. The shortening of the production period reduces the total cost due to time savings in material storage and material outfitting. With sufficient lead time, not only can procurement begin earlier, but total procurement time can be reduced.

Figure 2-1 is a chart showing the concept of IHI's material control system. The non-shaded portion shows material identification and scheduling of issuance of material specifications by the design department, taking necessary lead time for delivery to the work site for palletizing. The shaded portion shows the activity of the material procurement department which will be detailed hereafter.

2-2. PLANNING MATERIAL-BY-MATERIAL

To attain high performance in material procurement, the following procedures should be rationalized and standardized:

- What materials are to be identified? (Material identification.)
- At which design stage are the materials to be specified? (Material listing.)
- In what form are the materials to be specified in the purchase order specifications? (Material requisition classification.)
- How are materials controlled for procurement? (Material control classification.)
- How are materials purchased? (Material purchasing classification.)

The logic and principles of these procedures are illustrated in the judgment block chart, Figure 2-2.

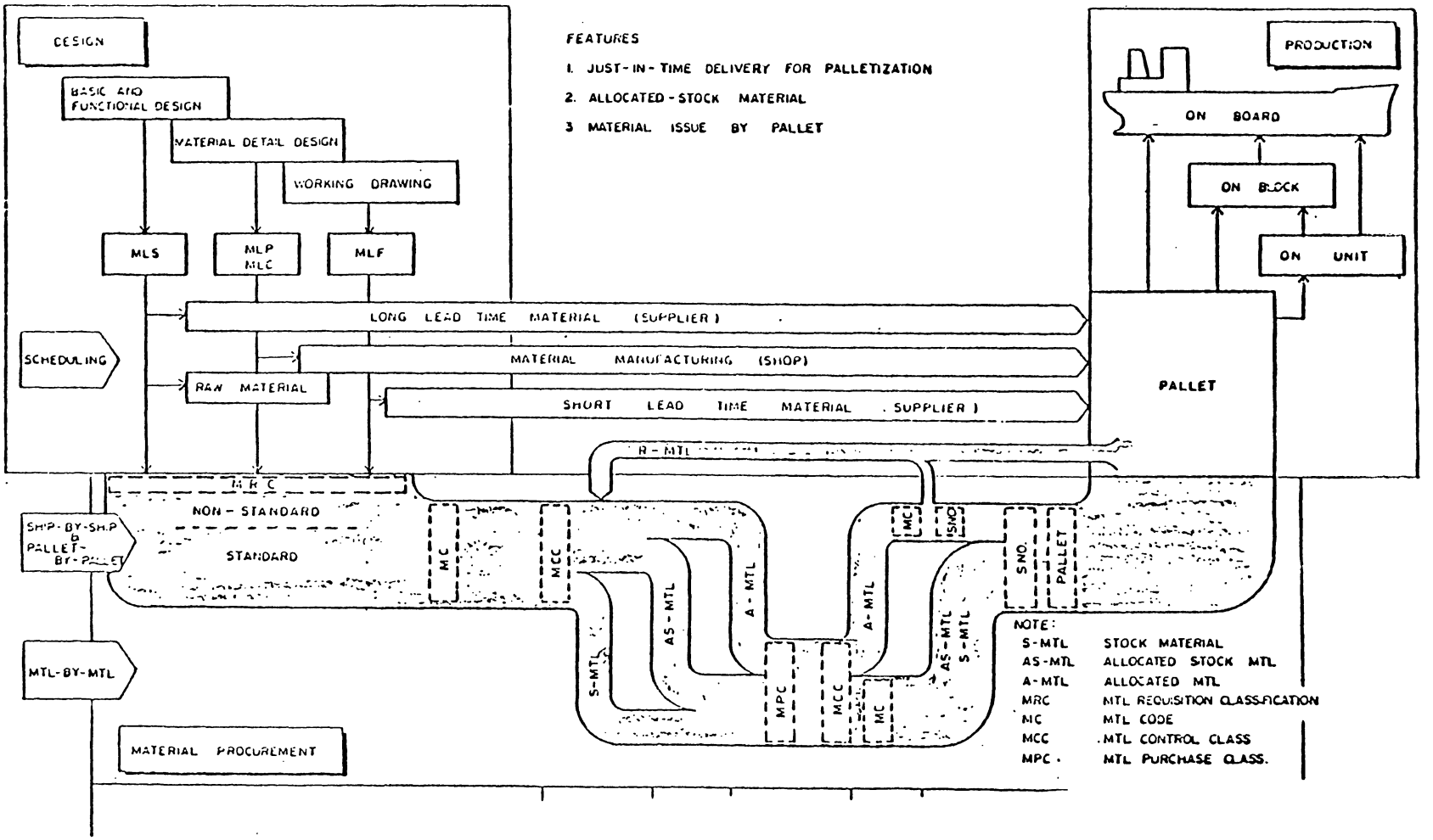


Figure 2-1. Grouping concept of the material control system at IHI.

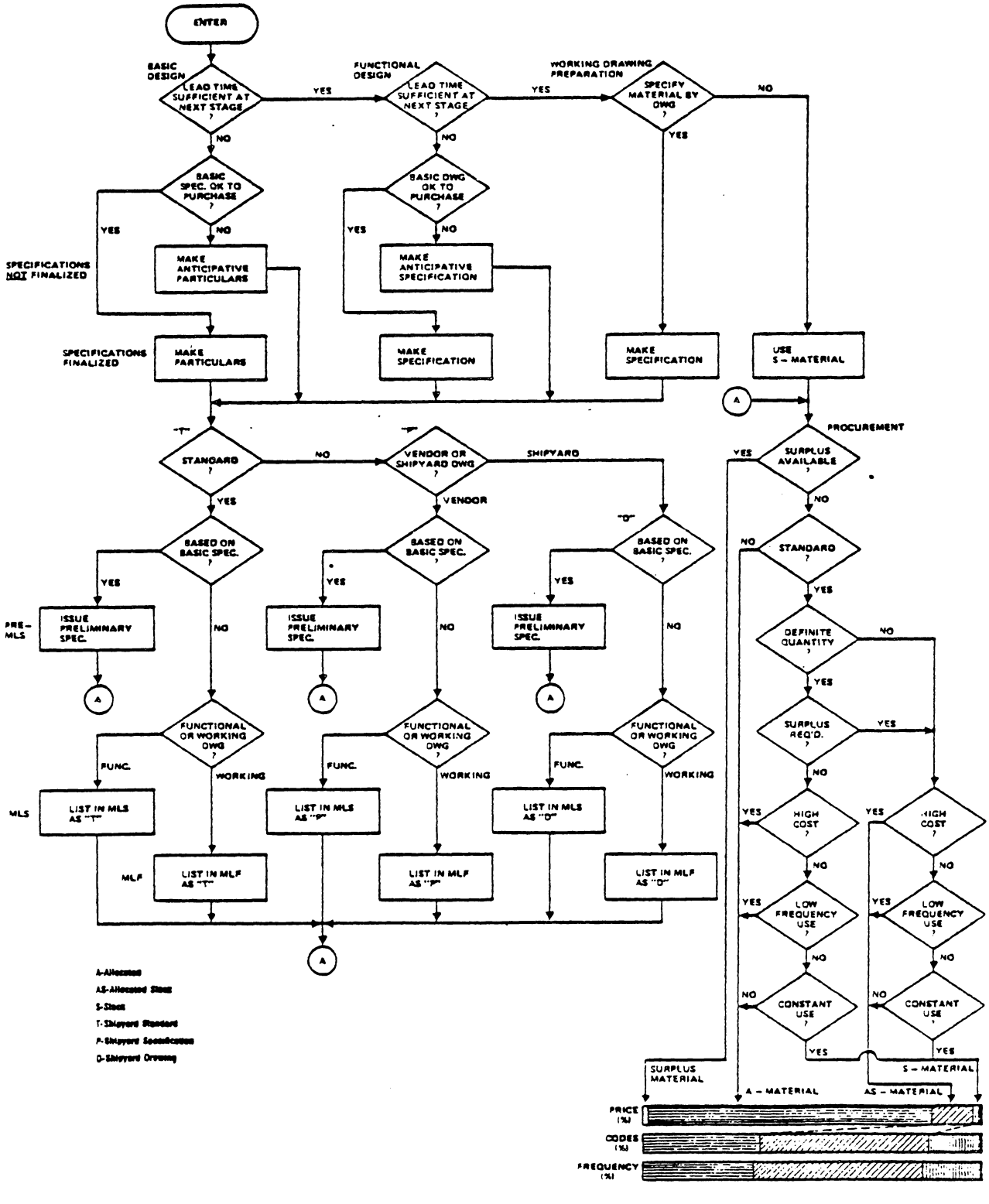


Figure 2-2. Material requirements definition. Percentages shown are for illustrative purposes only.

2-2-1. Material Identification

The first step is to clarify what materials are to be identified. The identification of materials is necessary, especially for zone outfitting, for the following purposes:

- Estimating, classified by each ship, by each system, and by each material.
- Engineering, classified by each ship, by each system, by each material, and by each zone.
- Material control and purchasing, classified by each material.
- Production, classified by each ship, by each zone, by each system, by each piece, and by each material.
- Cost reporting, classified by each ship, by each system, and by each material.

To fulfill these purposes, the following codes are utilized at IHI:

- Material code, which identifies what the material is, with detailed descriptions of what kind, type, size, grade, etc.
- Piece number, which identifies, serially in each system, at what part of the system the material is to be assembled.
- Pallet code, which identifies at which level, on which zone, in what area, and at which stage the material is to be assembled for each particular ship.
- Material cost classification number, which classifies in which system of each ship the material will belong.

Figure 2-3 shows the identification codes for material, which illustrate the categorization of the material code, the outline configuration of the material code, and the piece number. Figure 2-4 shows the structure of material cost classification, which illustrates the structural categorization for cost reporting and estimating of the material.

2-2-2. Material Listing

This is to identify at which design stage and in which material list the materials are to be specified. The time schedule for issuing design and pur-

MATERIAL	W/S	MATERIAL IDENTIFICATION				IDENTIFICATION ON SHIP
		COMMONNESS	REQUISITION CLASSIFICATION	STANDARDIZATION	MATERIAL CODE	PIECE NUMBER
	HULL CONSTRUCTION	STEEL MATERIAL SHIPBUILDING GRADE	AS	SKETCH SIZE	MATERIAL/GRADE/SIZE	SHIP/BLOCK/SUB-BLOCK/ SERIAL NUMBER
				STANDARD WITHIN A SHIP		
				STANDARD		
		OTHER MATERIAL	SAME AS FITTING			
	FITTING	COMMON	AS & S	INDIVIDUAL	BLANK/FULL DESCRIPTION	SHIP/SYSTEM/SERIAL NO.
				FAMILY	NIL	
			A	INDIVIDUAL	BLANK/FULL DESCRIPTION	
				FAMILY	BLANK/FAMILY DESCRIP.	
		NON-COMMON	AS & S	INDIVIDUAL	SYSTEM/FULL DESCRIP.	
				FAMILY	NIL	
			A	INDIVIDUAL	SYSTEM/FULL DESCRIP.	
				FAMILY	SYSTEM/FAMILY DESCRIP.	

A – ALLOCATED MATERIAL
AS – ALLOCATED STOCK MATERIAL
S – STOCK MATERIAL

Figure 2-3. Identification codes for material.

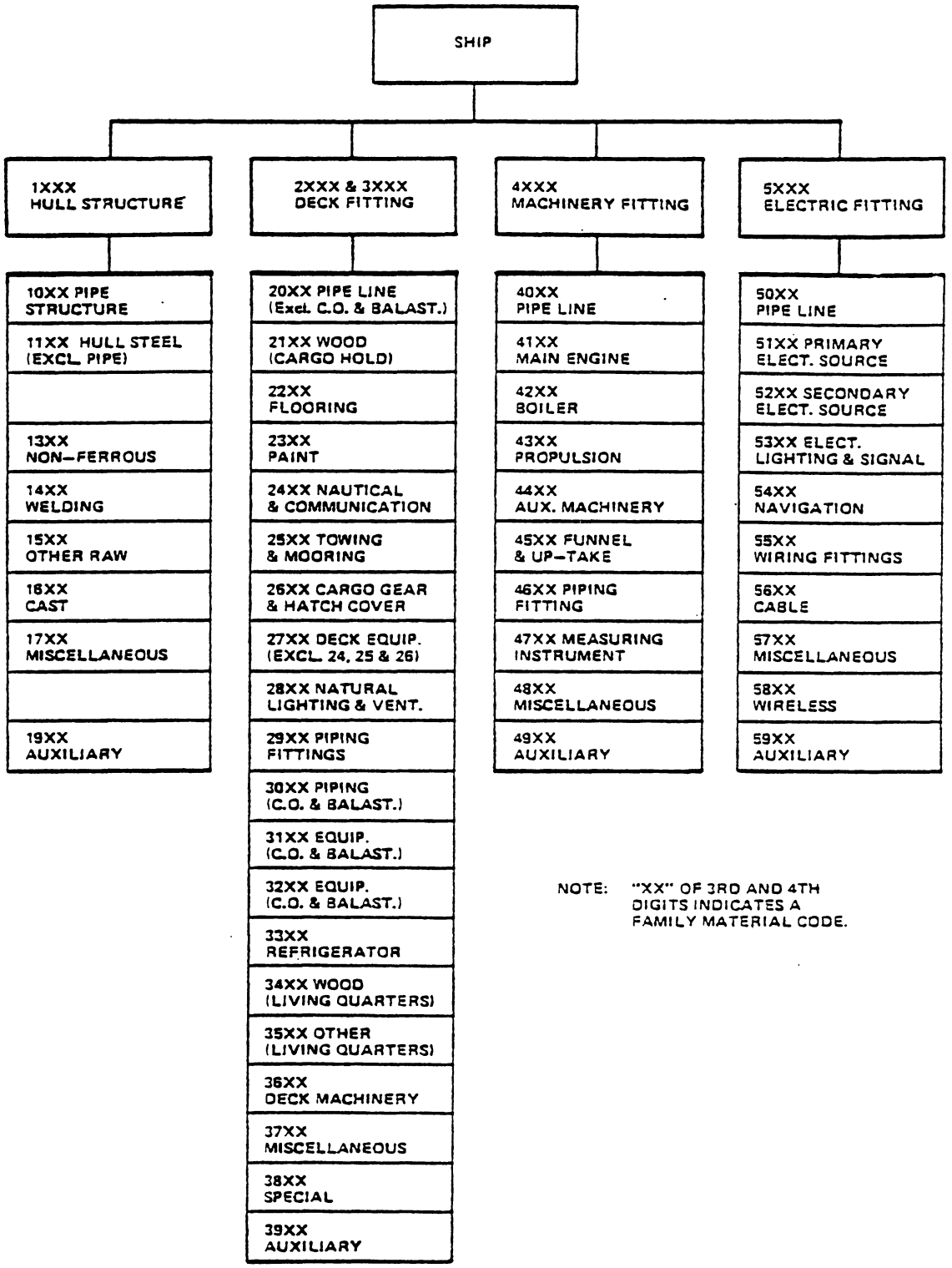


Figure 2-4. Structure of material cost classification.

chase order specifications is dependent on the lead time required by the vendor for material procurement. Therefore, the design schedule is dependent on the material procurement schedule which, in turn, is dependent on the delivery date required by production. As illustrated in Figure 2-2 and extracted as Figure 2-5, material specifications and lists are prescribed at each design stage, i.e., at the basic design stage, functional design stage, and work preparation design stage. These specifications are prepared in two ways, i.e., as "not finalized" or "finalized." The former is tentatively prepared if the details are not yet finalized, and it will be replaced with the latter when the details are finalized at a subsequent stage. The survey of required vendors' lead time for each material should be made beforehand to establish a standard for lead times.

It is very important to start material procurement with specifications that give clear and accurate particulars, exact quantities and required delivery dates. Accordingly, specifications should be finalized as early as possible to allow enough lead time for purchasing. When preparing the specifications, priority is given to longer lead time materials so that procurement can take action before the deadline, dated back from the required delivery date to production for palletizing.

Based upon these considerations, IHI has standardized the priority of materials that should be procured at the stages of basic design, functional design, and work preparation design.

Material specifications are listed in the following material lists:

· Pre-MLS which is to be used only for listing materials based on preliminary specifications prepared at the basic design stage, and this will be replaced by the following lists at subsequent design stages.

· MLS (abbreviation of Material List for Specification) which is to be used for listing materials classified by "T," "P," or "D" at the functional design stage and this will be updated, as necessary, at the work preparation design stage.

· MLF (abbreviation of Material List for OutFitting) which is to be used for listing materials for each pallet, classified by "T," "P," or "D" at the work preparation design stage.

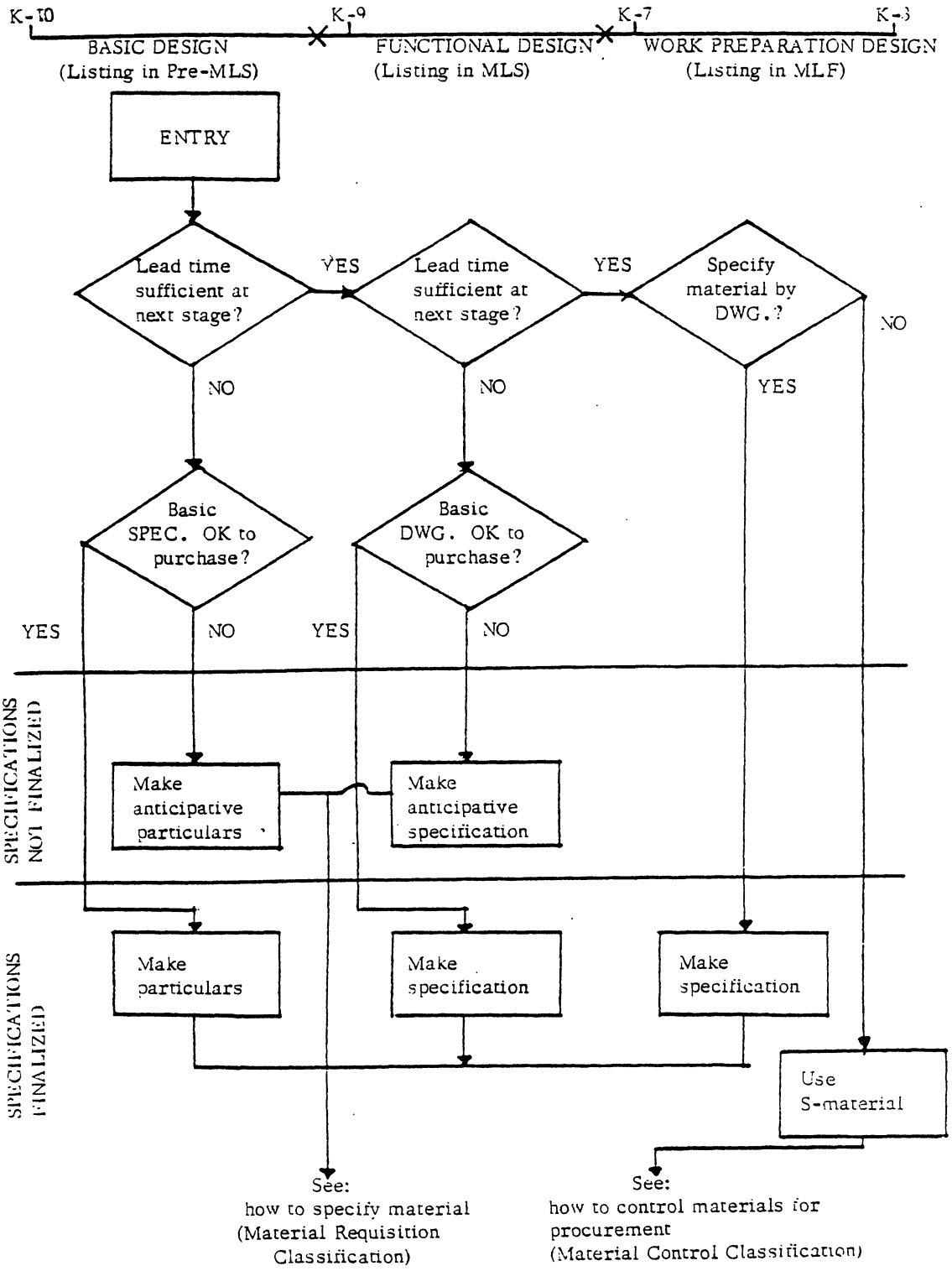


Figure 2-5. Material listing.

The definitions of "T," "P," and "D" are detailed in the following section on Material Requisition Classification.

2-2-3. Material Requisition Classification

This classification indicates in which form the materials should be specified. One way to prolong the lead time for procurement is to shorten the time to prepare the specifications. To attain a compatible solution, one of the most effective means is to standardize:

- Materials.
- Specification forms.
- Material lists.

The above standardization permits the procurement procedure to be shortened, leaving a longer lead time for negotiations with the vendor and/or a longer time for production.

The judgement block chart illustrated in Figure 2-2 and extracted as Figure 2-6 indicates how each type of drawing ("standard," "vendor's," or "shipyard's") at each design stage should be documented, that is:

- What types of specifications.
- Which stage of material list.

Earlier commencement of work and lower production cost can be attained by requisitioning by accurate specifications, standardiztion of material, and simplification and expedition of procurement. For this purpose, IHI has standardized materials as well as the procurement procedure.

Materials are specified in the following documents:

- Pre-specification, which is to be used only to specify material particulars for issuing the letter of intent.
- T-list (T is abbreviation of Table), which is to be used to list the materials registered as shipyard's standard. A T-list is actually the MLS or MLF, whichever is applicable.

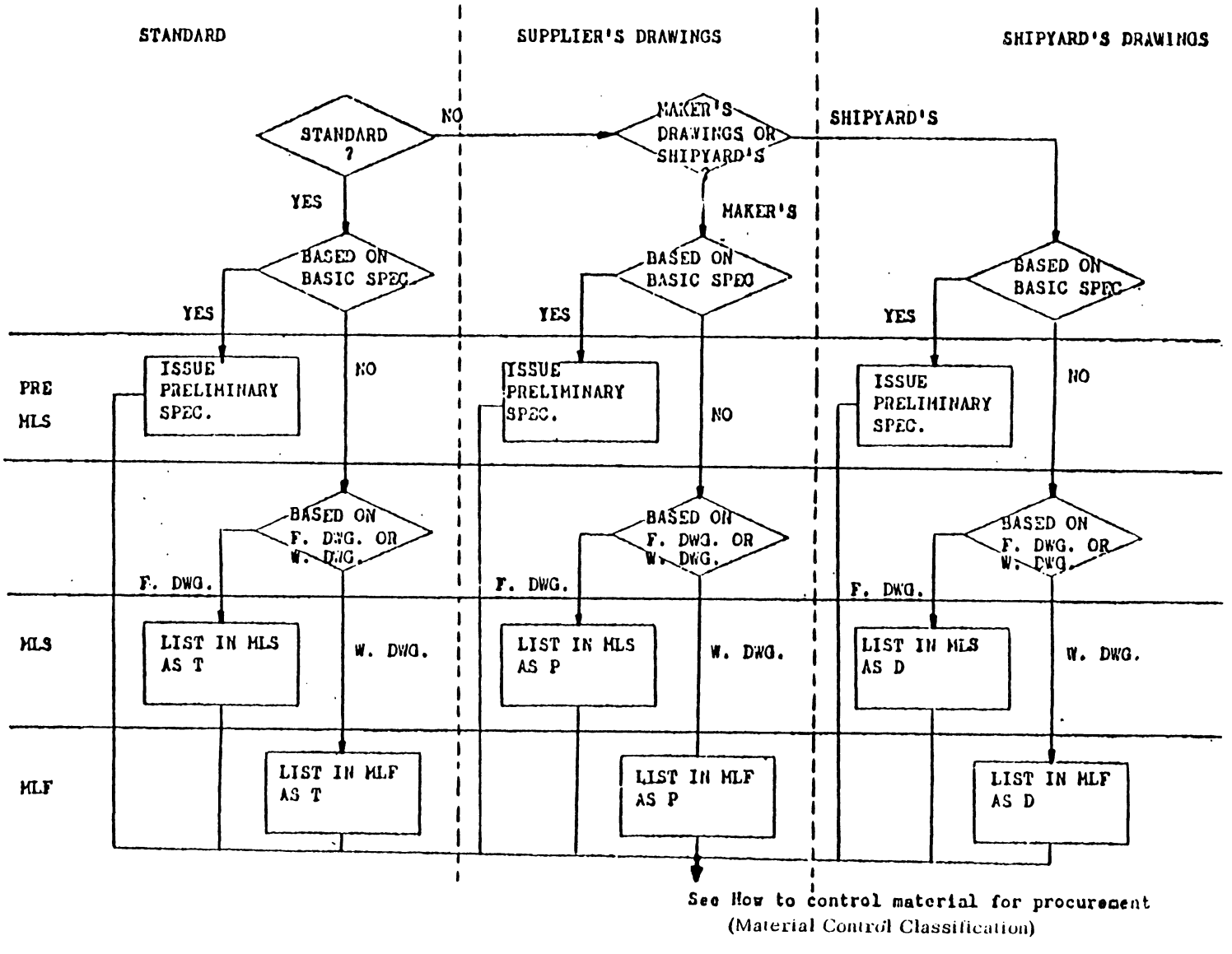


Figure 2-6. Material requisition classification.

- P-specification (P is abbreviation of Purchase order specification), which is to be used to specify the materials that should be manufactured in accordance with the vendor's drawings and/or standards based upon the shipyard's specification.
- D-specification (D is abbreviation of manufacturing Drawing), which is to be used to specify the materials that should be manufactured in accordance with the shipyard's specifications and drawings.

2-2-4. Material Control Classification

This classification indicates how to control material for procurement based upon the characteristic of the material. The target is to minimize the stock quantity while maintaining a suitable margin to avoid lack of material when requested.

For this classification, the following procedures are standardized:

- Which way is the material quantity to be requisitioned, with or without anticipation?
- Which material should be kept, with (or without) surplus stock?
- Which way is the material requisitioned, by design or by past statistical data?

For the materials requiring surplus stock, quantity and lead time are fixed but should be updated as necessary.

The judgement block chart is illustrated in Figure 2-2 and extracted as Figure 2-7.

Even if the specifications or quantity or the required date could be precisely planned, it is possible that the actual consumption will differ from the original plan due to unforeseen factors and/or changes. To compensate for these differences, an intermediate material control classification, "AS-material," is classified between "A-material" and "S-material."

A-material - means Allocated material that should be requisitioned by the quantity specified by the design.

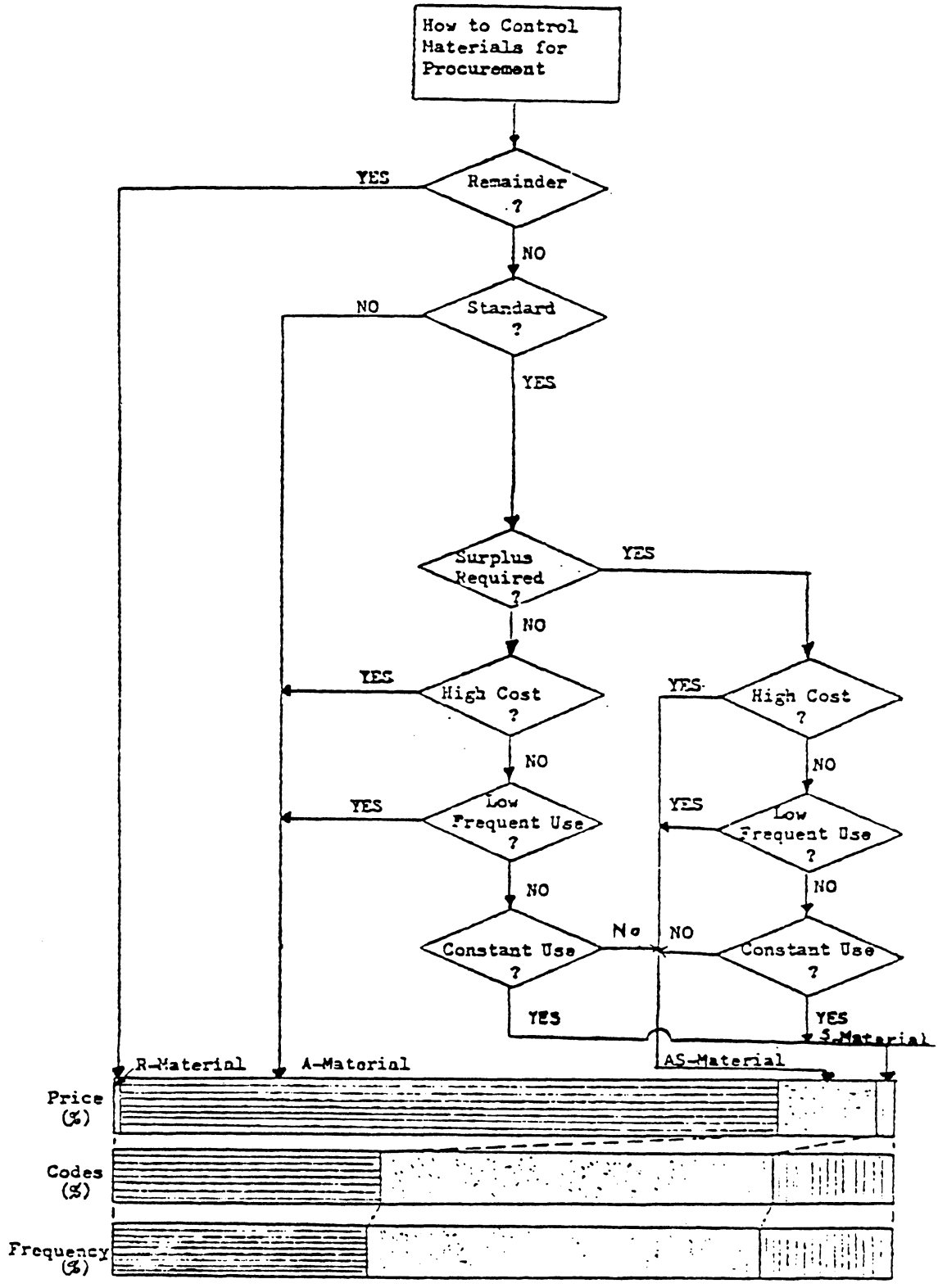


Figure 2-7. Material control classification.

AS-material- means commonly Allocated Stock material that should be requisitioned by the quantity specified by design, plus some surplus for unforeseen changes.

S-material - means Stock material for common consumption that should be requisitioned in most economical quantities, based upon estimates from past statistical data and/or forecosts.

R-material - means Remaining material which are leftovers from previous jobs, formerly A-material.

2-2-5. Material Purchasing Classification

This classification indicates how to purchase material by standardization of purchasing procedures, which, in effect, speeds up purchasing decisions, shortens the lead time, and reduces the purchaser's paperwork and manpower. In order to take full advantage of the above, long term agreements should be made as much as possible with the vendors. Figure 2-8 illustrates how to classify the material purchase procedures, and shows how much of the manpower required for tenders and negotiations could be reduced by standard purchasing procedures.

The standard purchasing procedures applied at IHI are as follows:

Spot Order - Purchasing takes action only when the purchase requisition is released. Based upon the price of one order, spot orders are split into:

- Simplified Procurement Procedure - price less than 30,000 yen
- Ordinary Procurement Procedure - price more than 30,000 yen

Long Term Agreement - Purchasing based on an agreement with the vendor for a certain period, containing some terms and conditions. Depending on the terms and conditions, the agreement is split into:

- Order Base Contract - To fix the vendor's price.
- Consignment Base Contract - To fix the vendor's unit price and secure appropriate stock for the shipyard, based upon the shipyard's consumption forecast. There are two alternatives for storage, one is to store the stock at the vendor's warehouse, and the other is to store it at the shipyard's warehouse.

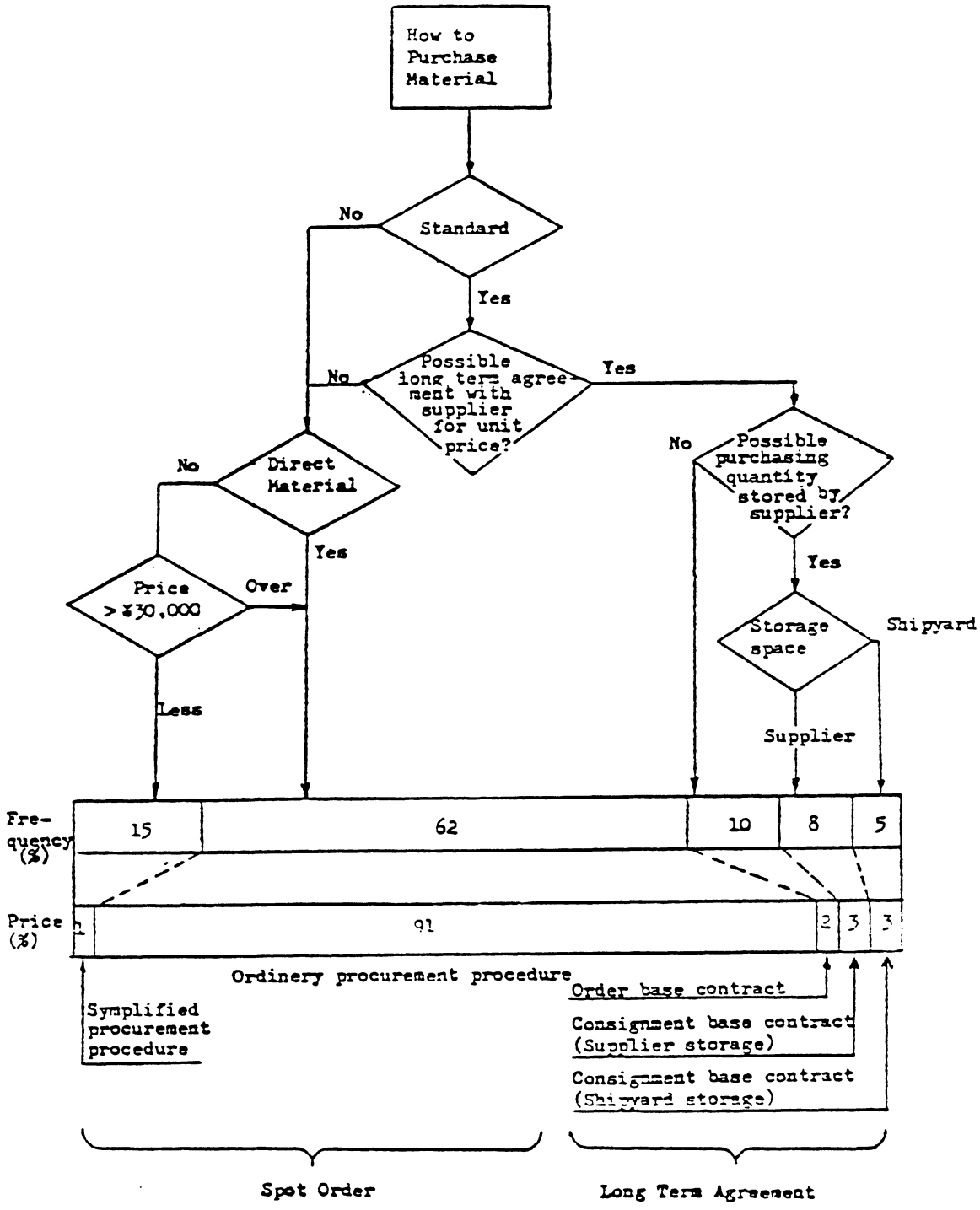


Figure 2-8. Material purchasing classification.

As shown in Figure 2-9, these procedures enable omission of part of the usual material procurement process required for ordinary spot orders.

2-3. PLANNING SHIP-BY-SHIP

Material procurement is basically processed and planned material-by-material, because of the vendor's expertise, convenience in common use of the material and material handling. But planning ship-by-ship is constantly required to take measures to comply with any changes in production progress and/or scheduling.

2-3-1. Plan-Do-See Meeting among Sections Concerned

This meeting helps to check the material procurement from the viewpoint of planning ship-by-ship. Every section in charge can recognize beforehand the status of progress (ahead or late), or changes in design, material procurement and/or production.

The users can obtain information on whether the material is on schedule or not, and, if necessary, revise the schedule in advance to meet the required delivery date. The triangle shown in Figure 2-10 illustrates the departments concerned and the items to be communicated. It is normally unnecessary to discuss routine jobs among the departments, because drawings, output from computer, etc., enable the persons in charge to work together smoothly. The meeting is held once a month and is grouped into four units:

- Interior Fitting.
- Deck Fitting.
- Machinery Fitting.
- Electric Fitting.

2-3-2. A-Material Procurement

A-material is procured under the control of material-by-material planning. However, the requisition and issuing is made ship-by-ship. To keep the material issue on schedule, checks for procurement progress and revisions are always executed ship-by-ship. Figure 2-11 illustrates the above logic.

Procedure \ Process			Consumption Forecast	Material List Release	Requisition Order Release	Purchasing, Tender & Negotiation	Purchase Order Release	Production Period	Material Receipt	Payment Order Release	Storage Area	Material Issue
Spot Order	Ordinary Contract		X	O	O	O	O	O	O	O	O	O
	Simplified Contract		X	X	X	O	X	O	O	O	X	X
Long Term Agreement	Order Base Contract		O	O	X	X	X	O	O	O	O	O
	Consignment Contract	Supplier Storage	O	O	X	X	X	X	X	O	X	O
		Shipyard Storage	O	O	X	X	X	X	X	O	O	O

Figure 2-9. Processes required under various material acquisition procedures. (X indicates process not required.)

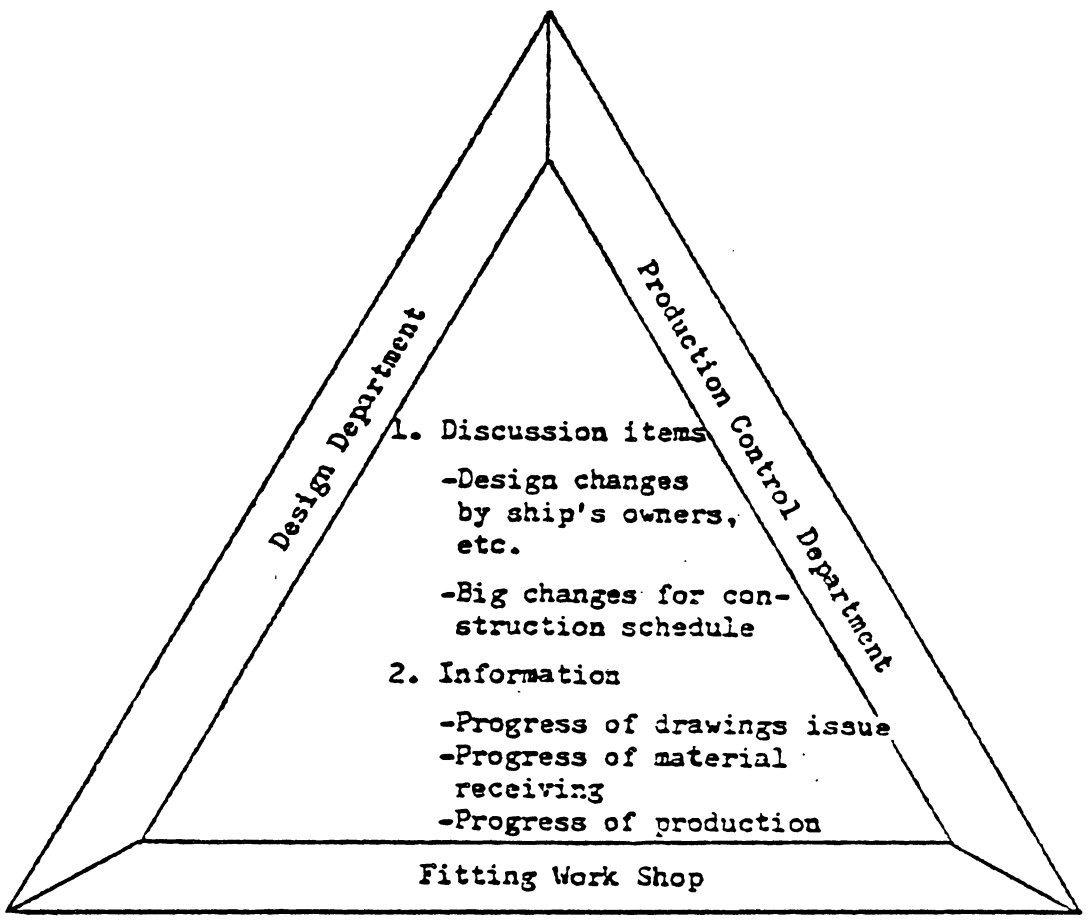
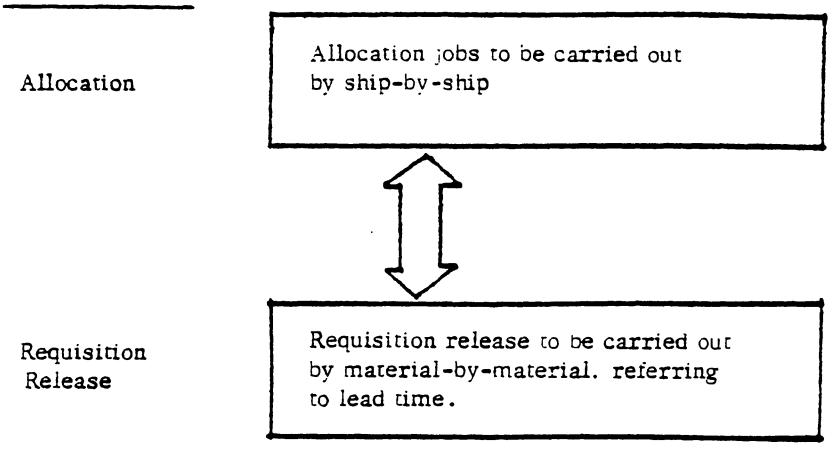
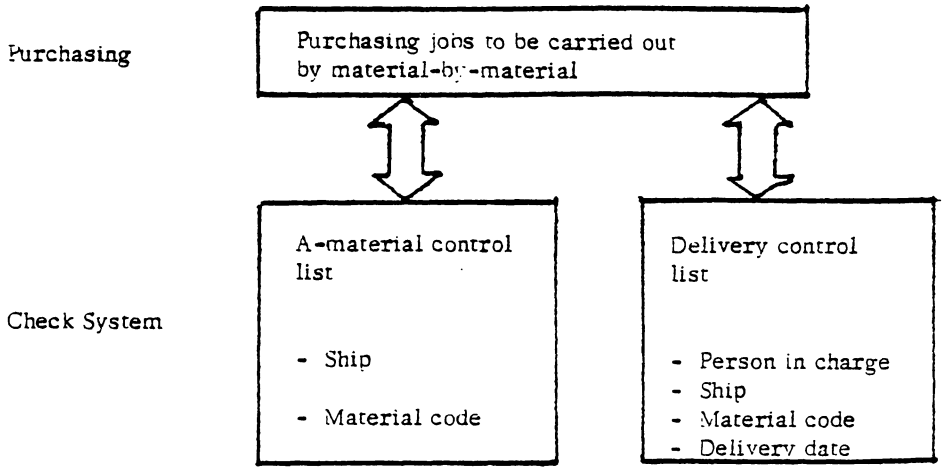


Figure 2-10. Plan-do-see meeting.

- Material control



- Purchasing control



- Warehousing control

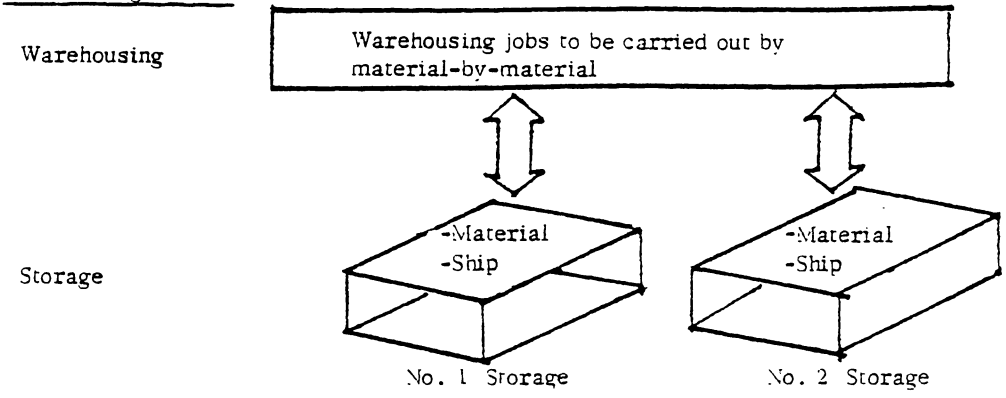


Figure 2-11. A-material control.

2-3-3. AS-Material Procurement

AS-material is characteristically the same as A-material. But, as shown in Figure 2-12, the routine and check systems are different from those for A-material.

2-3-4. Palletizing for Material Issue

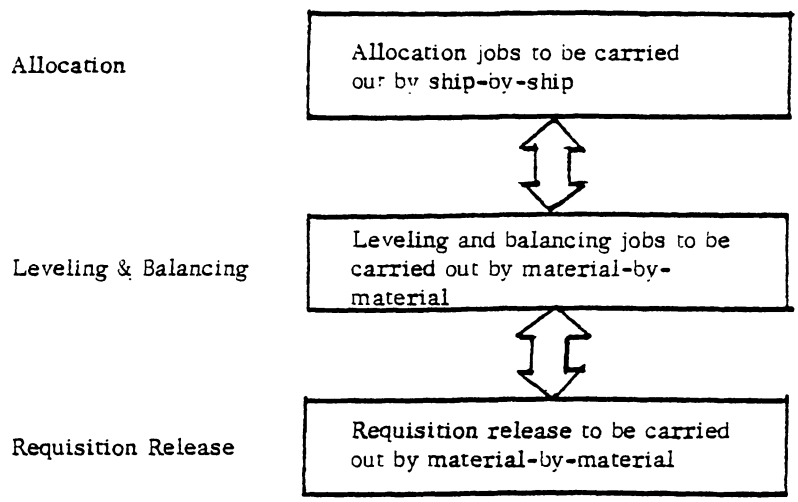
The process stated so far is based upon receiving the materials on schedule. This is most important for production control. Since unit and/or zone outfitting will be smoothly performed by palletization of material, any lack of material will entail decline in productivity, confusion in the production schedule, and loss of manpower.

Palletizing is the last function of material procurement, and it is the connecting process between material procurement and production. Accordingly, the planning of functions switches over from material-by-material to ship-by-ship and pallet-by-pallet.

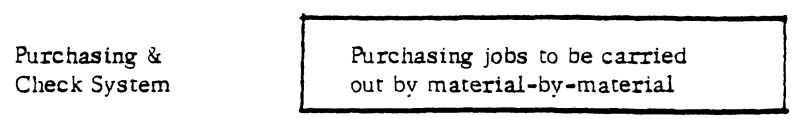
Figure 2-13 shows the flow of palletization between the warehouse and the palletizing shop. Notable points are:

- Fabricated components, e.g., ladders, tanks, etc., are delivered directly to the storage area of the palletizing shop.
- Final palletization is executed by the palletizing shop.
- Partial palletization of materials in warehouse is executed by the warehouse.

- Material control



- Purchasing control



- Warehousing control

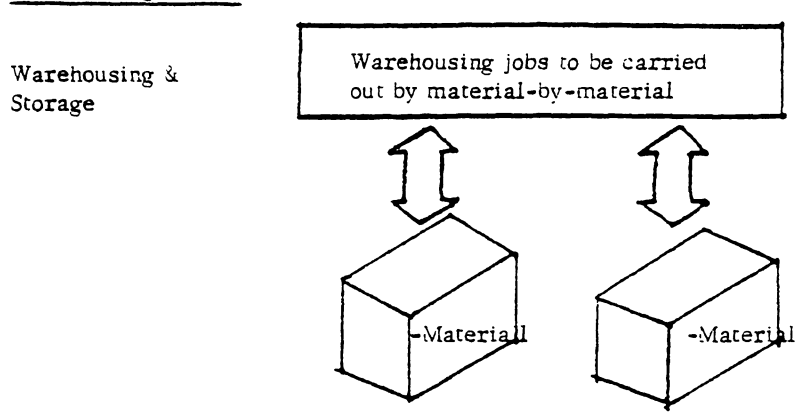


Figure 2-12. AS-material control.

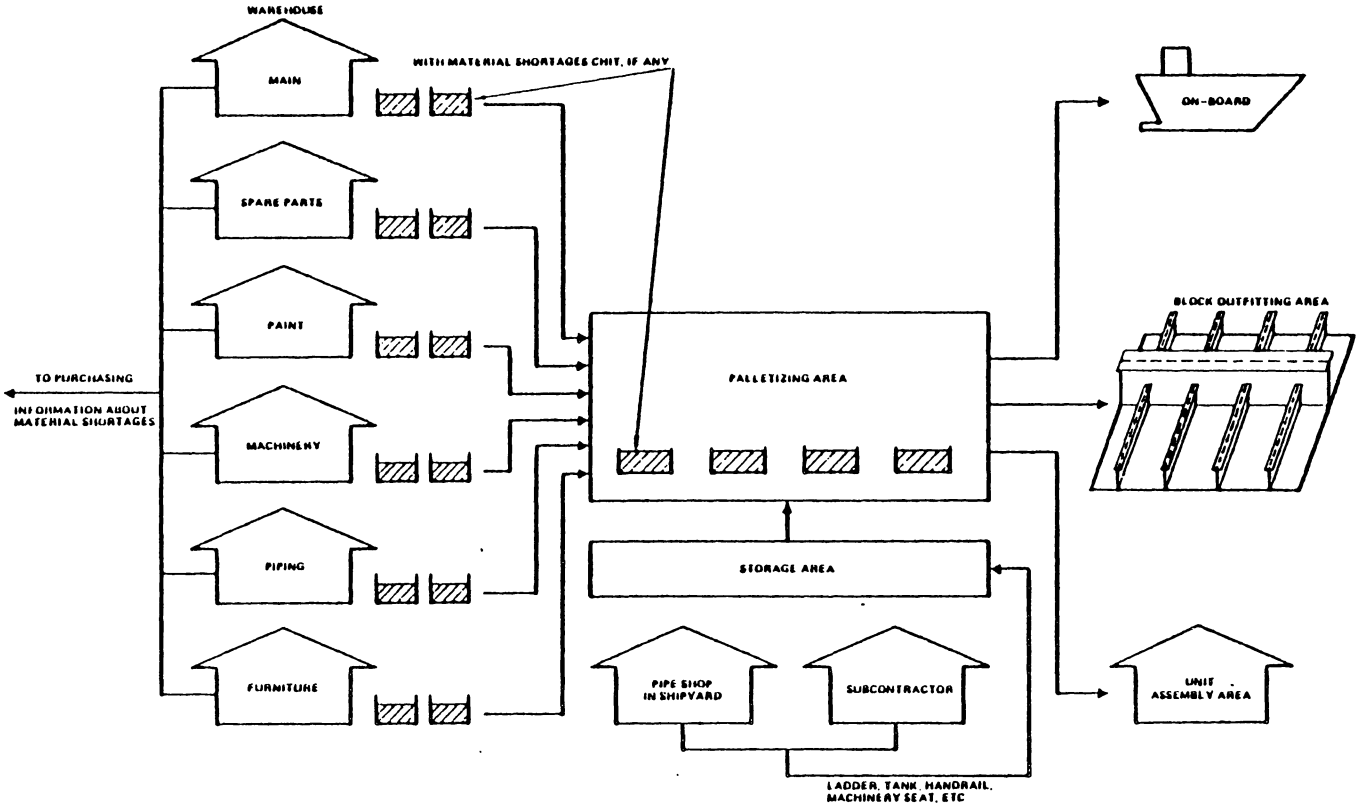


Figure 2-13. Palletizing for material issue.

III. SOME PROCESSES OF MATERIAL PROCUREMENT

In this section, some principles for minimizing stock requirements are introduced.

3-1. LEVELING AND BALANCING FOR MATERIAL REQUISITION

The logic flow of leveling and balancing, shown in Figure 3-1, gives a procedure for calculating the quantity of requisitioned material that must be purchased. This logic is practically applied only for AS-material, but the same general idea is also applied for A and/or S-material.

For A-material, the requisition is made subject to the input of design data, without considering any margins in quantity. In contrast, for S-material the requisition is based upon statistical data regardless of design data.

If AS-material, which includes some margin in the quantity required for each ship, is purchased ship-by-ship and system-by-system, the possibility of over-purchasing will increase, causing undesirable dead stock by accumulation of the margins. The solution is to frequently check and level the quantity of the purchased material for all ships under construction. The leveled quantity is obtained by summing up the estimated quantity and the consumed quantity, per month, per ship, referring to the quantity estimated by the design.

By leveling the stock, the following advantages are obtained:

- Suitable margin for "safety stock."
- Minimize inventory value.
- Economic purchasing lots.

3.2 ASSURANCE OF REQUISITIONED MATERIAL

With the progress of design, the accuracy of material consumption estimation becomes higher and higher. The following are procedures to assure higher

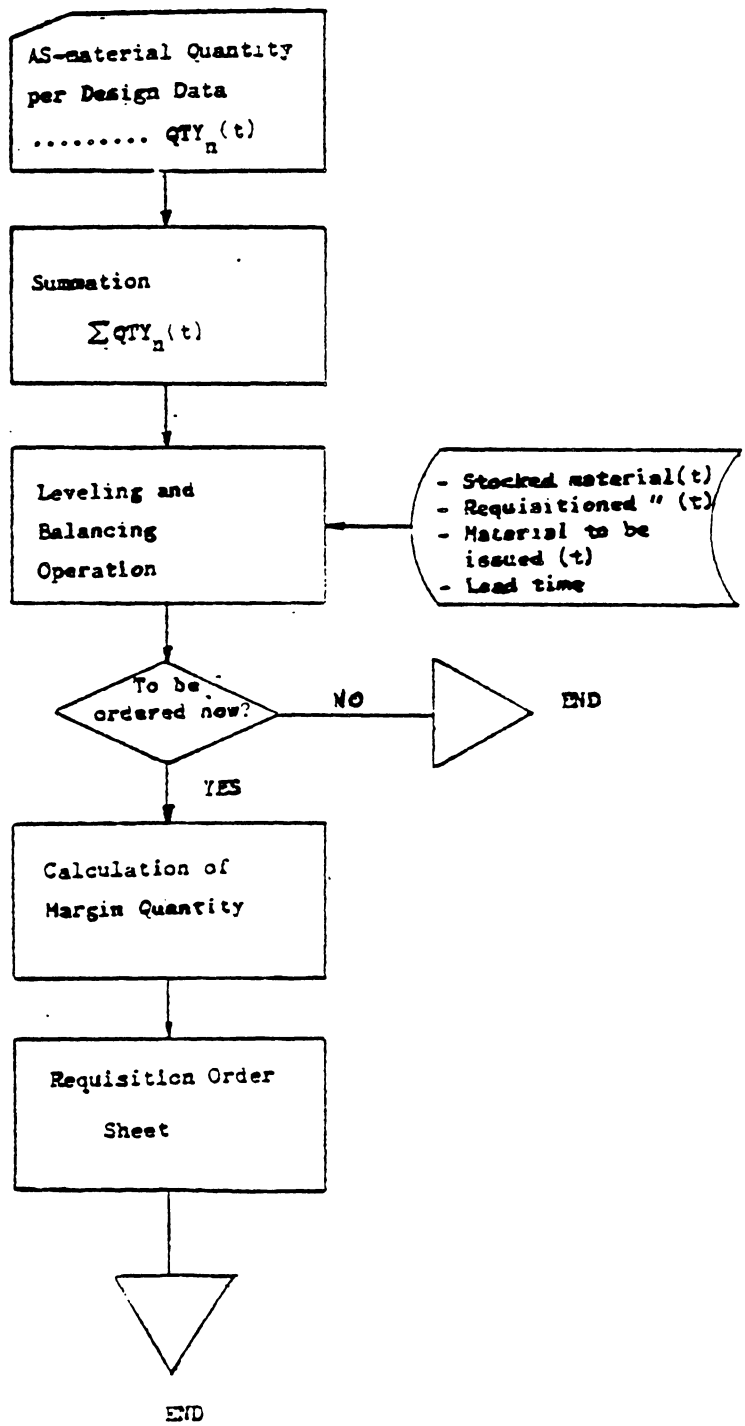


Figure 3-1. Logic flow of leveling and balancing.

accuracy at earlier stages. Figure 3-2 shows the relationship and the updating sequence among drawings, material lists, and purchase orders.

Purchasing based upon definite final drawings cannot make purchasing and production periods shorter. So, in order to purchase necessary materials as early as possible, purchasing is based on anticipated quantities, and updated with the progress of design.

The anticipated quantity often differs from the actual consumed quantity. To avoid these differences, the quantities are compared and adjusted in advance at the check points upon completion of:

- Functional design.
- Work preparation design.

The quantity obtained in work preparation design replaces that of functional design at the following time, whichever comes first:

- Completion of the work preparation design.
- When the quantity of material developed in work preparation design exceeds that of functional design.

For the purposes of early requisition of materials, decisions on quantity should be made at the following stages based on the user's required date as yardsticks:

- Functional drawing. Date of fabrication start of the earliest pallet of each zone for hull construction.
- Work preparation drawings. Date of fabrication start of each pallet.

The dates fixed at the preceeding stage will be replaced, as necessary, by the ones of the subsequent stage.

As mentioned before, three types of material list will be issued. An MLS is issued earliest but its data will be based on anticipated quantities and, thus, will not be so accurate. An MLF is issued later but the data are accurate. An MLCP is also issued later with the data relating to MLS and MLF. As these material lists are issued at different stages, with different accu-

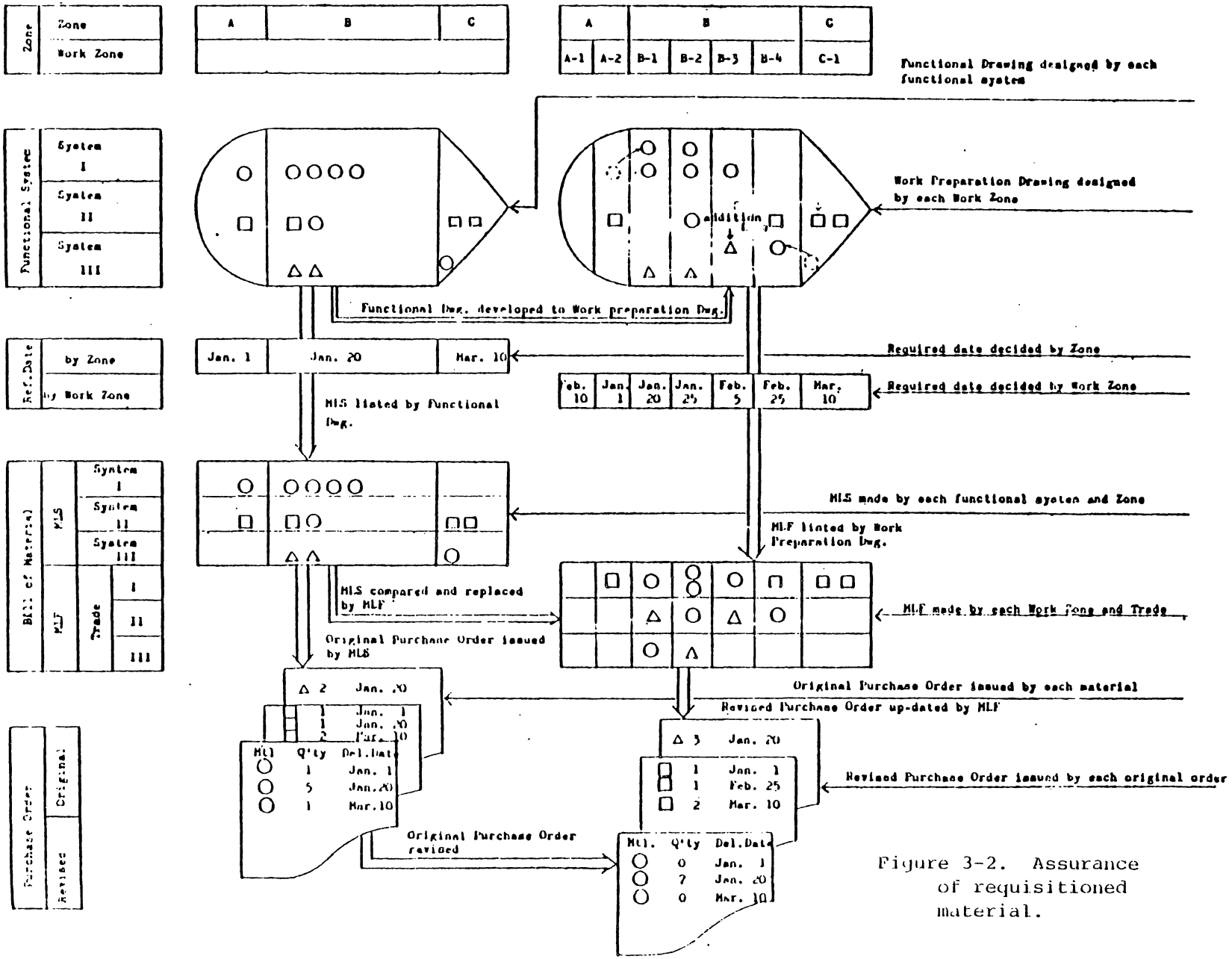


Figure 3-2. Assurance of requisitioned material.

racy, and with different characters, they are checked among each other and adjusted, as necessary, to make them valid.

3-3. LEAD TIME CALCULATION FOR DETERMINING DELIVERY DATE

One of the important functions of material procurement is the standardization of timing for various actions of material procurement. As a result, easy forecasting and scheduling of subsequent actions can be made, and action can be taken earlier.

Figure 3-3 shows "material procurement - timing" as a model, and Figure 3-4 shows "material timing control and lead time" as the basis of the former model.

To shorten the required period a careful survey of lead time should be made and the possibility of shortening the time required for each factor should be examined.

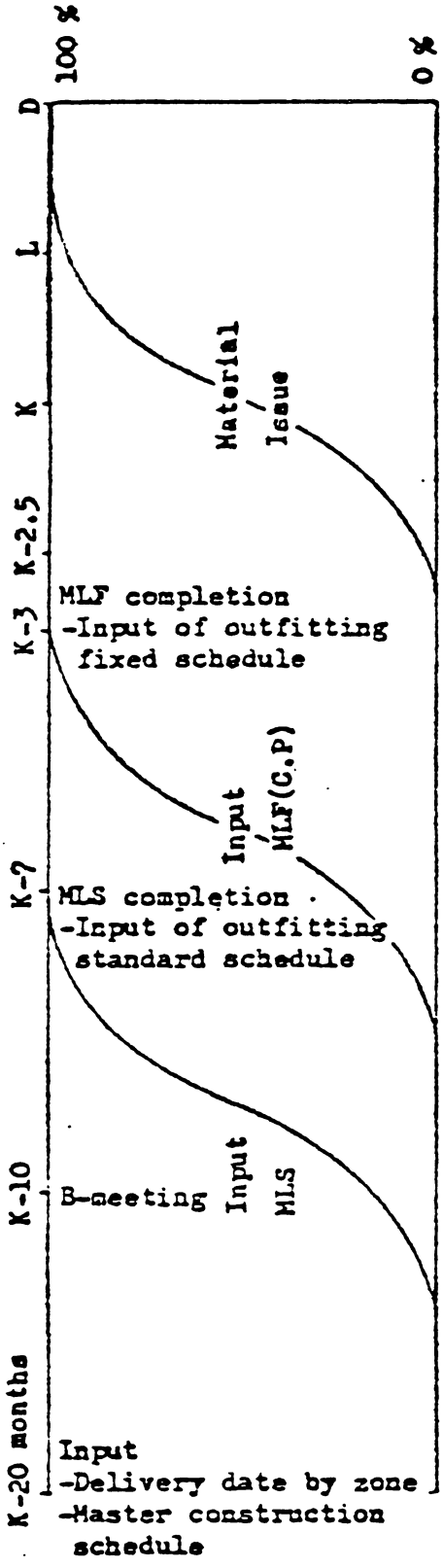


Figure 3-3. Material procurement timing.

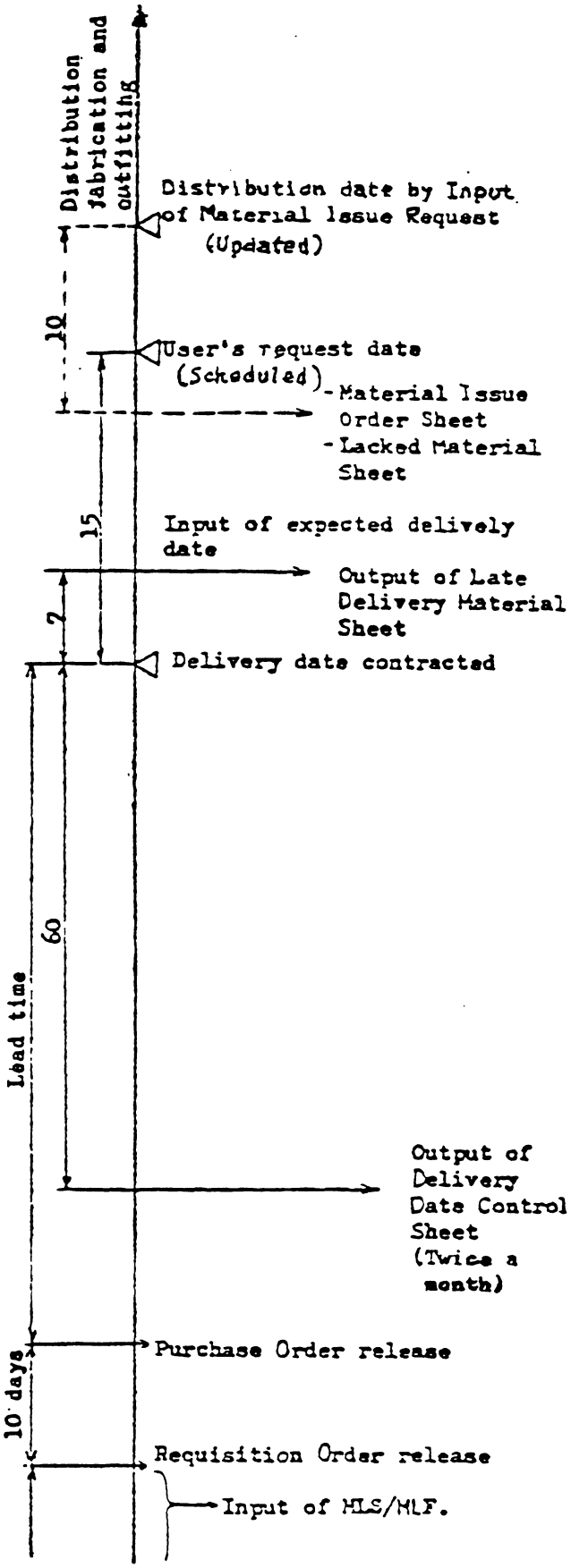


Figure 3-4. Material timing control and lead time.

IV. COMPUTER-AIDED MATERIAL CONTROL AND RELEVANT SYSTEMS

4-1. FLOW OF MATERIAL CONTROL SYSTEM

The flow chart shown in Figure 4-1 represents the outline of IHI's material control system which covers the functions of material control and relevant systems. The system is aimed at:

- Eliminating repetitive writing jobs in the subsequent functions.
- Leaving writing, sorting, calculating, and other clerical jobs to the computer, and letting the computer generate final clerical printouts.
- Leaving controlling, judging, and other managerial tasks to the human being, and letting the computer generate necessary reference data.

4-2. RATIONALIZATION BEFORE COMPUTERIZATION

Material control

1. Classification of material:
   - Material Code.
   - Material Control Classification.
   - Material Supply Form Classification.
2. Effectiveness of material control:
   - To study and settle material control classification for avoiding material shortage at minimum stock.

Design

1. Standardization of design:
   - To standardize design and formats.
   - To minimize varieties of standards considering prices and handling.
2. Standardization of suppliers:
   - To make long term agreements with certain vendors material-by-material, selected by cost and quality.

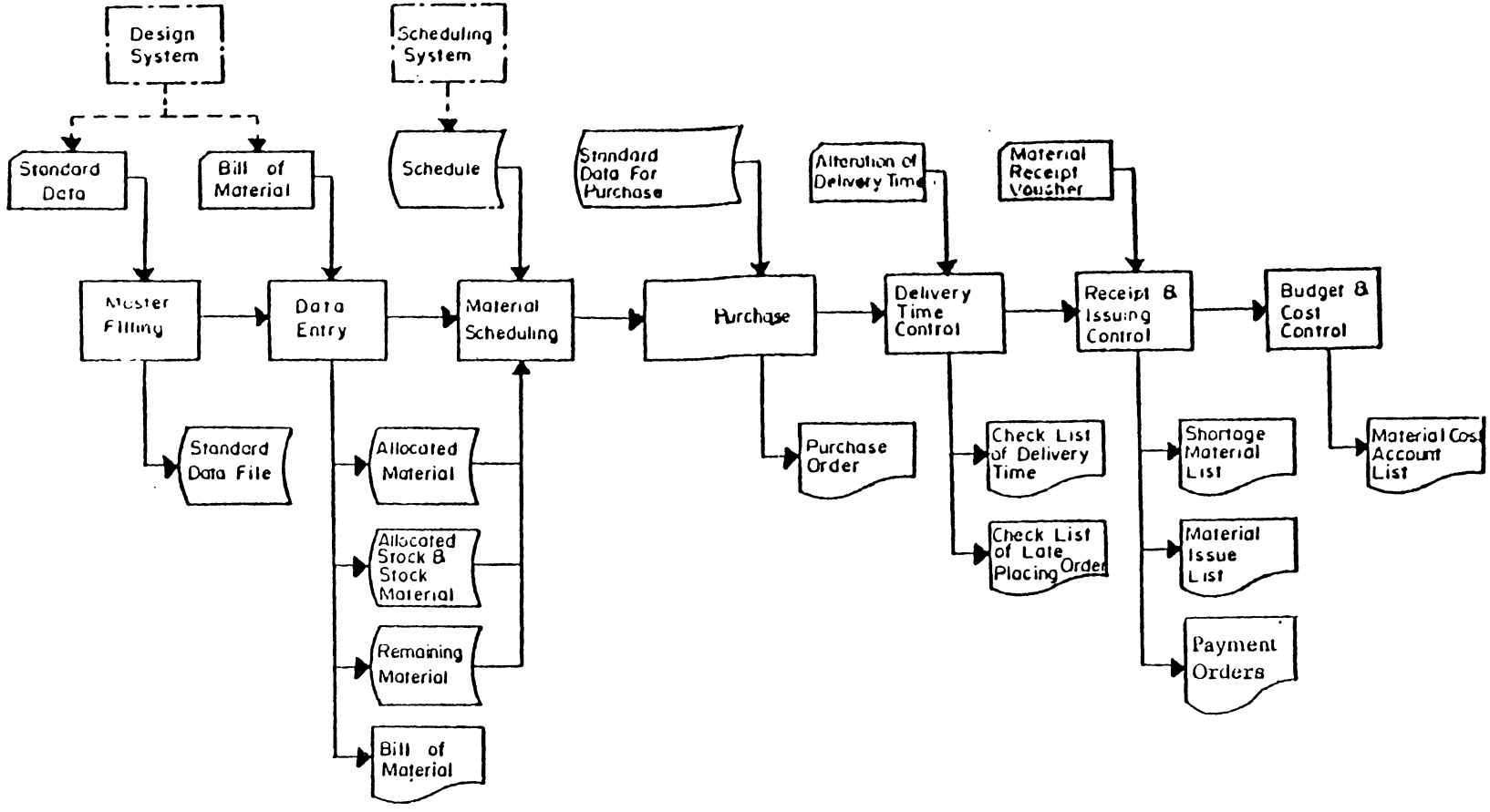


Figure 4-1. Flow chart of material control system.

3. Clarification of exceptional cases:
   - Owner's special requirements.
   - Expedited delivery.

Purchasing

1. Standardization of purchasing procedures:
   - To contract long term agreements.
   - To contract delivery and payment terms.
   - To contract procedures for drawing approval.
2. Classification of purchasing procedures:
   - To clarify purchasing procedure material-by-material.
     - Spot order.
     - Long term agreement.
     - Consignment base contract.
3. Propagate long term agreements.

Warehouse

1. Receiving, issuing, and storing of material in accordance with material control classification.
2. Standardization of material palletizing procedures.

4-3. ADVANTAGES OF COMPUTERIZATION

1. The following instructions can be easily made to meet progress in production:
   - Expedited delivery.
   - Sequence of issuing of drawings.
   - Quantity and delivery date of material.
   - Issuing materials.
2. Job control can be easily planned based on control data.
3. Purchased quantity can be easily identified.
4. Delivery date can be calculated both from user's request date and lead time.

5. Reduction of manual calculation and posting of:
   - Payment order.
   - Cost accounting.
   - Bookkeeping.
6. Production cost can be rapidly identified.
7. Comparison between budget and cost.
8. Early discovery of exceptional or emergency matters.
   - Late issue of drawings.
   - Late issue of purchase orders.
   - Late delivery of materials.
   - Mis-issue of material.
9. Prevention of errors owing to manual calculation and writing.
10. Standardization of job procedures.
11. Less skill required for job procedures.

AIIM SCANNER TEST CHART # 2

Spectra

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6 PT ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz;:'',./?$0123456789

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Times Roman

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Greek and Math Symbols

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8 PT ΑΒΓΔΕΞΘΗΙΚΛΜΝΟΠΦΡΣΤΥΩΧΨΖαβγδεξθηικλμνοπφρστυωχψζ≧∓'',. / ≦±=≠°><⊁⊀⩾⩽≡

10 PT ΑΒΓΔΕΞΘΗΙΚΛΜΝΟΠΦΡΣΤΥΩΧΨΖαβγδεξθηικλμνοπφρστυωχψζ≧∓'',. / ≦±=≠°><⊁⊀⩾⩽≡

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MESH HALFTONE WEDGES

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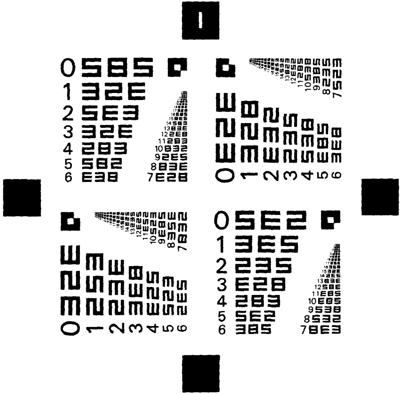
RIT ALPHANUMERIC RESOLUTION TEST OBJECT, RT-1-71



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ROCHESTER INSTITUTE OF TECHNOLOGY, ONE LOMB
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