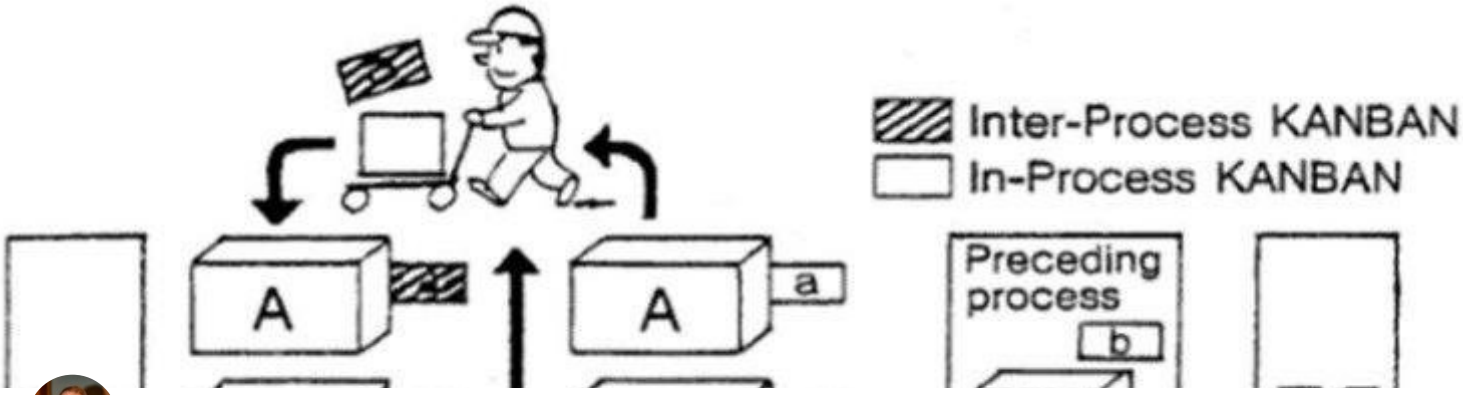


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Experienced Manufacturing Professional "Discovering Solutions with People"

# 1989 TPS Handbook - Kanban System

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Toyota supplied a small army of trainers/coaches at the startup of NUMMI (New United Motor Manufacturing, Inc. - joint venture between Toyota and GM) and TMMK (Toyota Motor Manufacturing Kentucky) through about year three. As a commitment to 'growing people', both had about 600 trainers that served on three-month rotations to coach the managers and supervisors on how to run the Toyota Production System (TPS). This manual was directed more towards making sure their internal production system operated as expected. Their production system was already stable, so the kaizen examples will show only rather small improvements, as they were copying a sister plant in Japan.

In 1989 Toyota Motor Corporation, International Human Resources Division, Production Control Division, produced a manual detailing four of their primary tools.

1. **Kanban System**
2. **Jidoka**
3. **Standardized Work**
4. **Kaizen**

> *The discussions are focused on the tools and not a general explanation of TPS, for that you should read the 1973 version of the TPS Manual.*

## Kanban System

### Background and Nature of the Kanban System

### The Origin of Kanban

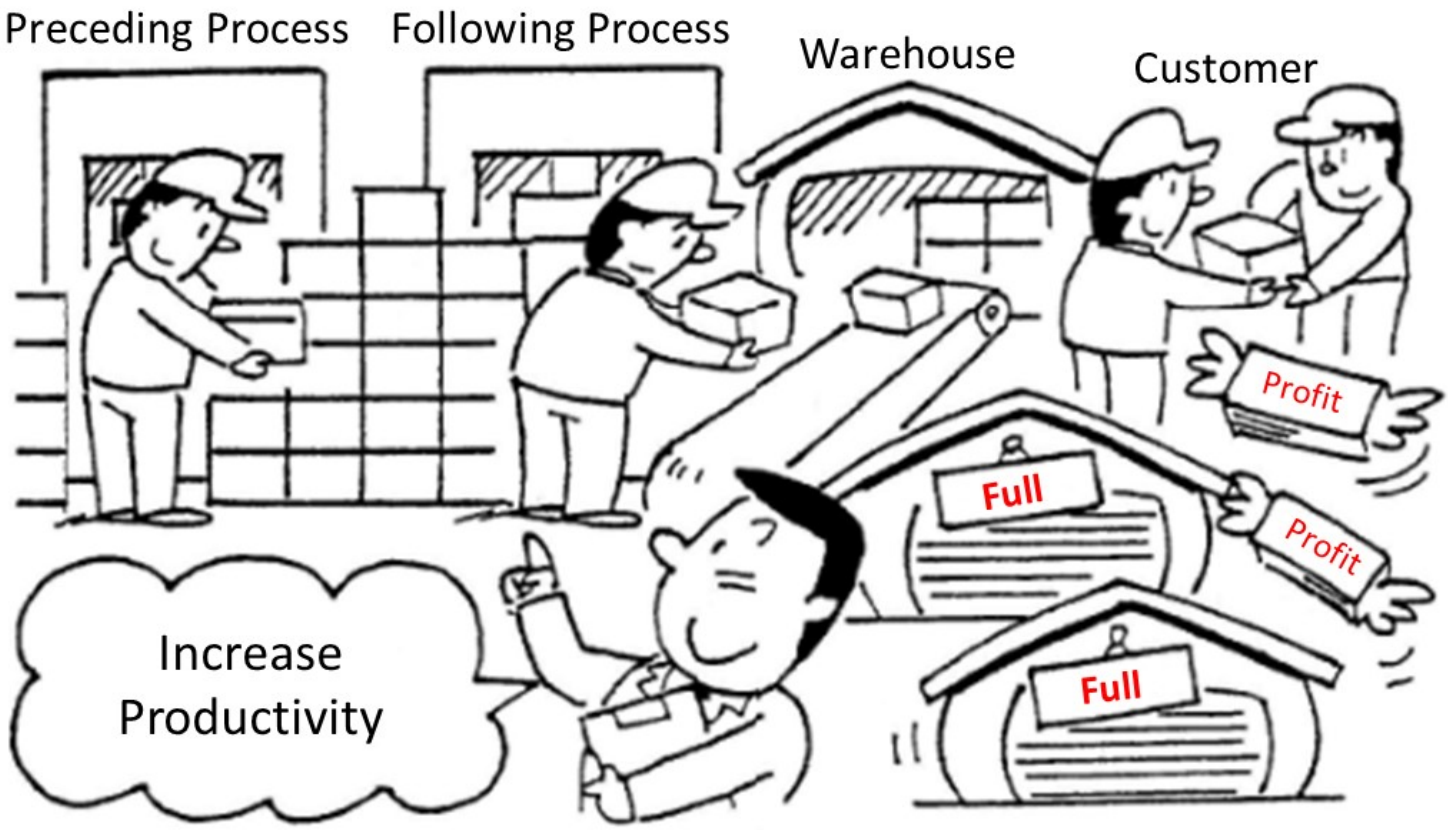
The original idea for kanban came from supermarkets. The customer essentially selects what they want, when necessary, in the quantity desired. The grocer organizes and arranges produce in such a way that the customer can do this easily.

The supermarket manages its sales operations based on demand by stocking the shelves with produce according to the brands and quantities purchased by the customer. This is the idea behind *fill-up supply*.

Kanban is a tool (countermeasure) to achieve *Just-In-Time* production, which is; to supply the right parts, at the right time, in the right amount. (*Flow*) [1]

### The General Production System

The organization of the Kanban System differs from the traditional or general production system. In a traditional system, material is delivered to the job site based on a production schedule; a previous process supplies parts to the next process based on this information.




In this system, each process manufactures and delivers the parts based on the schedule, however it is subject to a variety of problems as follows.

- Because workers are worried about meeting a schedule and avoiding work delays, they tend to buffer or overproduce parts. [2]
- Because parts are sent continuously to the next process, inter-process inventory builds up. This hides other problems. [3]
- Because work-site wants to have high productivity that may produce more than production schedule.
- Because scheduled production usually means lot production, die set-up time and production lead time are not high priority items. Lot production obscures the need for improvement in these areas.

In contrast, the Kanban System is a withdrawal system in which the following process goes to the preceding process to withdraw the parts it needs. [4]


## Preconditions

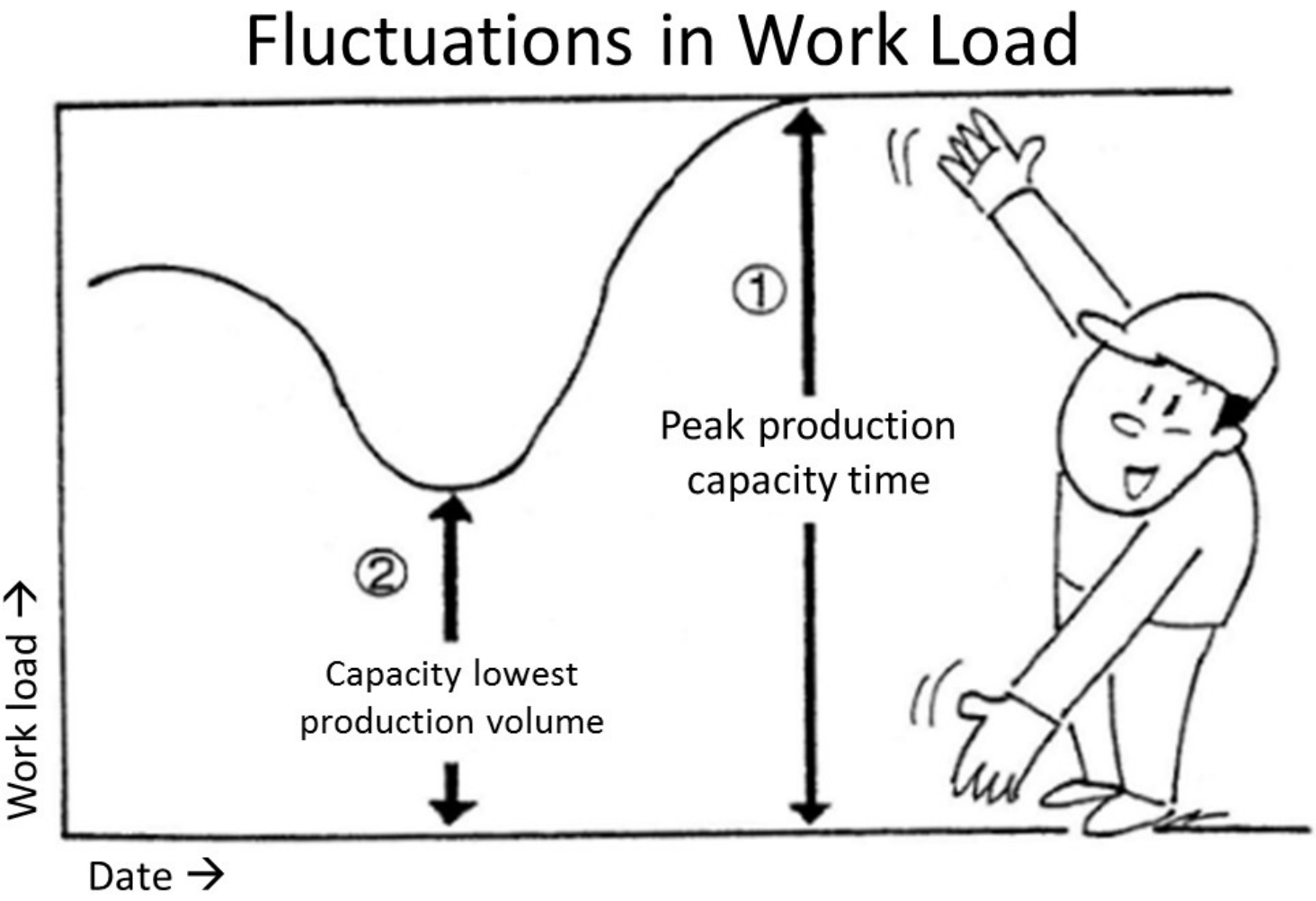
Preconditions for Establishing the Kanban System. [5]

## Heijunka or Leveled Production [6]

Fluctuations in the load or the amount of work occur in the production process.

Note the illustration, the vertical axis represents the work load. The horizontal axis represents the month and day. If the production capability is adjusted to the peak work load at (1), there will be waste at non-peak times; if the capability is matched to the low work load at (2), however, peak level production will be impossible to achieve.

It's clear, that the ideal situation is to maintain smooth or leveled production with as little fluctuation as possible.

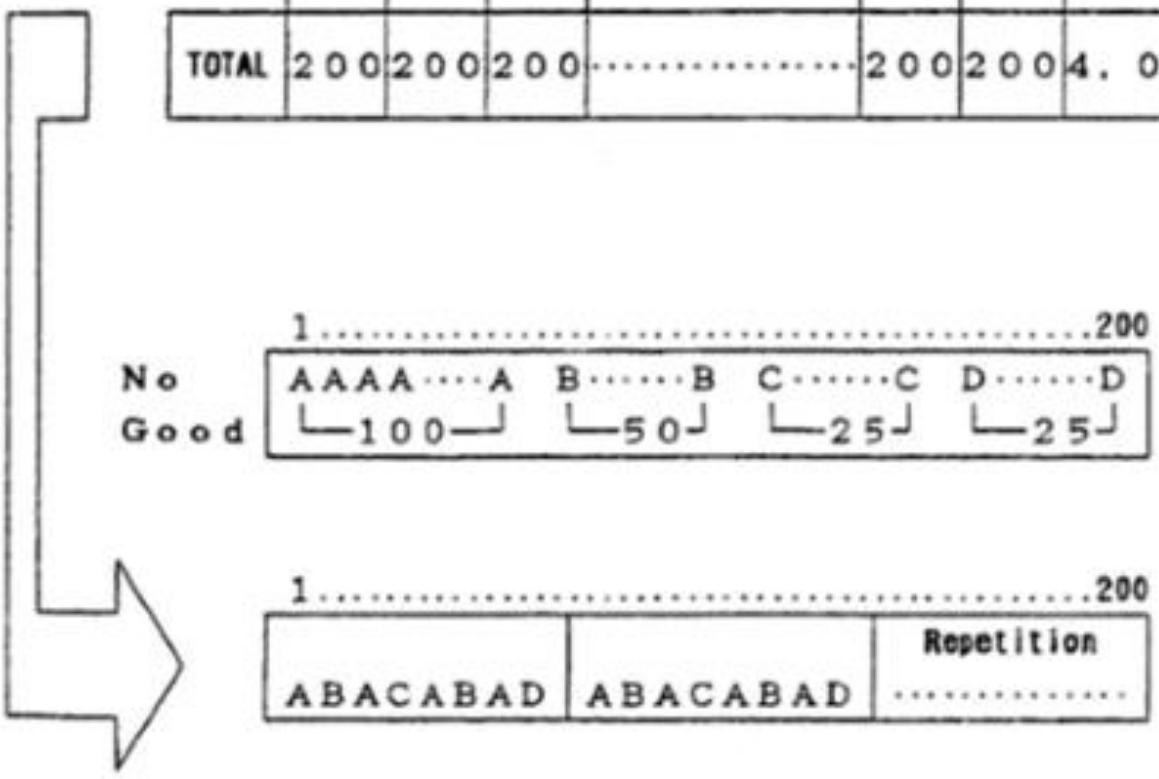



There are 2 types of work load fluctuations: fluctuation in the total amount, and fluctuation in the amount of each type. Leveled production is important.

It is based on the average of the total amount, and the amount of each type within the range of manufactured parts to be sold.

# Heijunka Production Plan

| DAY | 1 | 2 | 3 | | 19 | 20 | TOTAL |
|---|---|---|---|---|---|---|---|
| | A 100 | A 100 | A 100 | ..... | A 100 | A 100 | 2,000 |
| | B 50 | B 50 | B 50 | ..... | B 50 | B 50 | 1,000 |
| | C 25 | C 25 | C 25 | ..... | C 25 | C 25 | 500 |
| | D 25 | D 25 | D 25 | ..... | D 25 | D 25 | 500 |
| TOTAL | 200 | 200 | 200 | ..... | 200 | 200 | 4,000 |




Example: Operation days = 20

**A** 2,000 units/month

**B** 1,000 units/month

**C** 500 units/month

**D** 500 units/month

4,000 units/month = TOTAL

A, B, C and D represent vehicle types in the assembly process or a type of part (part number) in the vehicle's preceding process

Leveled production has 3 meanings:

**First**, leveled production of the total daily production quantity;

**Second**, standardization of types in daily production, and

**Third**, standardization of procedures.

Consider leveled production in terms of the total quantity.

Since A + B + C + D = 4,000 and there are 20 operational days, the formula 4,000/20 gives us a daily production quota of 200 vehicles. This is a good beginning; however, we must go a step further.

The quantities of each type must also be leveled.

In the case of A, 2,000/20 = 100/day;

In the case of B, 1,000/20 = 50/day; and

In the case of C and D, 25/day.

The daily production schedule is then prepared: a total of 200 vehicles must be produced each day in the following proportion:

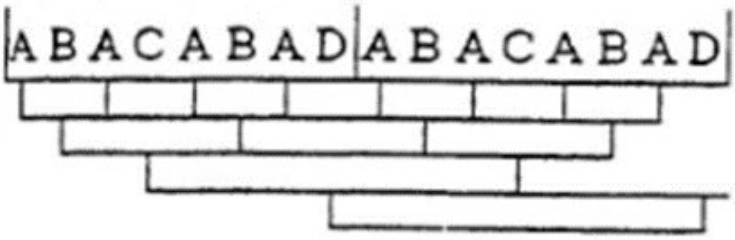
A = 100, B = 50, C = 25 and D = 25.

Consider the sequence in which these quantities of vehicles are to be produced. This also involves production leveling. Vehicles should be produced at as even a as possible.

The table, below shows how to arrive at the production quantity ratio.

| | Quantity/Day | Ratio |
|---|---|---|
| A | 100 | 4 |
| B | 50 | 2 |
| C | 25 | 1 |
| D | 25 | 1 |

Heijunka production will be achieved by repeating the following pattern:




...1 A is produced every 2 times,
...1 B every 4 times,
...and 1 C and 1 D every 8 times

Heijunka production is calculated by computer.

## Stabilizing the Process

Kanban are signboards which issue production instructions to the preceding process. They are used when the following process has completely used up the quantity of parts they normally consume.

Stabilizing the process is important. For instance, if the preceding process is unstable, that is, can't supply the necessary quantity to the following process at the required time, (due to defects, production dispersion, or differences in quantity at certain times), the following process must wait. This frustrates any guarantee of production continuity.

One way to assure continuity is to accumulate large inventories of stock. However, this results in a build-

up of wasteful stock.

You can see the necessity of clearly understanding and solving the problem of stabilization before introducing the Kanban System.

## The Functions of Kanban

Kanban have 4 general functions:

1. To give instructions concerning production and conveyance

2. As a tool for visual control

i) To prevent unnecessary activity of overproduction

ii) To monitor progress and to detect delays in process

3. As a tool for process improvement.

4. As a means of making fine tuning adjustments in production

## Instructional Information about Production and Conveyance

Parts Withdrawal and Production Instruction kanban provide work instructions. They direct what, when, where, and how many parts to produce and convey.

They are a way to communicate information between the preceding and the following processes.

## Tool for Visual Control

Tools for visual control help us to monitor the accuracy, location, and flow of parts at a glance. Since kanban move together with the actual parts, they are an important tool for visual control.

Parts without a kanban can be easily identified. They are defective, misplaced, etc. or a kanban rule was not properly observed.

Visual control helps in two very important respects.

### To eliminate unnecessary activity of over-production

A kanban operational rule is to produce only the quantity of parts that is withdrawn by the following process. Manufacturing more parts than is necessary increases inventory and causes a variety of problems and loss.

For this reason, the following process must obey kanban rules. They must not take parts without a kanban, nor take more parts than specified on the kanban. This will help avoid unnecessary activity of overproduction.

### To monitor progress and detect delays in process

Heijunka or leveled production is a precondition for the production process. It fosters conditions for manufacturing a certain number of products in each interval.

Kanban can then be conveyed in the same given interval. If kanban pile up, it's clear that production has been delayed; if kanbans decrease, it's clear that production has increased too much.

## Kanban as a Tool for Process Improvement

If kanban are properly understood, they serve as a tool for visual control. As a result, line improvement is possible.

Having too many kanban increases inventory. Therefore, it's necessary to reduce their number. And if there is any dispersion of kanban, this must be checked, and the necessary countermeasures taken through continuous improvement. In addition, priorities in the production sequence can be determined from the increase or decrease of parts withdrawal by the following process and work adjusted accordingly.

## Kanban for Fine Tuning Adjustments

(suited only to small changes in production)

Once leveled production is accomplished, Kanban also serve to fine tune the amount of inventory. It must be pointed out, however, that leveled production is not always followed in daily production for various reasons. For example, (a) production delays, repairs to broken equipment, defective vehicles, etc. or (b) adjustments in the production schedule.

When these obstacles are small scale, a small quantity of stock at the line side can lead to recovery. In the case of a major change, however, small quantity of stock will lead to shortages and may stop the line. In which case, kanban cannot offer any countermeasures.

It's important to understand that countermeasures in such circumstances are required not only at the production site where the kanban are used but throughout the whole production control system, including order receipt (order receiving control), which precedes production.

## Operational Rules for Kanban

A good tool is one that effectively achieves its purpose. When used improperly, however, the same tool can impede progress. This is true of the kanban system. When properly used, it can be an effective tool for control in the work site.

## Operational Rules

There are 6 rules for the operation of kanban.

1. Defective parts are not to be passed on to the following process.

2. The following process goes to the preceding process to withdraw parts.

3. The quantity of parts produced must equal the quantity withdrawn by the following process.

4. Parts must not be produced or conveyed when there is no Kanban.

5. Kanban must be attached to the actual parts.

6. The number on the kanban must agree with the number of actual parts.

Let's study each rule in more detail.

**Rule #1:** Defective Parts Must Not Be Passed On To The Following Process.

Manufacturing defective parts means that material, equipment, and labor have gone into making parts that can't be sold. It's a major impediment to the corporate goal of reducing costs.

When defective parts are discovered, countermeasures must be taken to prevent a recurrence. This is given the highest priority.

To ensure quality, ***Rule #1:*** **"Defective Parts Must Not Be Passed On"**, is important. When observed,

- (a) the process which manufactured the defective parts is forced to confront the problem,
- (b) because by retaining detective parts, the following process may have to stop the line. This results in an accumulation of defective parts and alerts the supervisor and manager to the problem. They must act to remedy the problem.

**Rule #2: The Following Process Withdraws the Necessary Parts**

This rule requires that the following process withdraws from the preceding process parts only as required. Manufacturing too many parts or too soon and then supplying them to the following process causes problems.

For example;

- (a) unnecessary work, sometimes overtime,
- (b) excessive inventory,
- (c) needlessly installing equipment with excessive capacity because employees fail to realize they are producing superfluous parts,
- (d) slow implementation of countermeasures because problems are hidden behind excessive inventory and, most importantly,
- (e) unnecessary parts are produced instead of those that are required at the moment.

It's important to firmly establish this rule. The following process must not simply withdraw parts at its own discretion.

> *DO NOT TAKE PARTS WITHOUT A KANBAN*

> *DO NOT TAKE MORE PARTS THAN LISTED ON KANBAN*

> *ALWAYS ATTACH KANBAN TO ACTUAL PARTS*

These principles are crucial.

**Rule #3: The Quantity of Parts Produced Must Equal the Quantity Withdrawn by the Following Process**

This rule comes from Rule #2. Maintain only a minimum inventory of parts. To achieve this, DO NOT PRODUCE MORE PARTS THAN LISTED ON THE KANBAN and PRODUCE PARTS IN THE ORDER ON THE KANBAN. Observing these operational principles will result in the true effectiveness of Rule #3.

Strict observance of Rules #2 and #3 allows the Toyota Production System to function as though it were a single conveyor line. All processes are then **synchronized**. You can understand the benefits and importance of such a synchronized conveyor. It standardizes work and reduces cost.

**Rule #4: Do Not Produce or Convey Parts Without a Kanban**

This is the reverse of Rule #3. Kanban are the sole production instructions, and as such, parts are not to be manufactured without kanban. Issuing and attaching additional Kanban, after parts are made leads to the accumulation of unnecessary parts. This is prohibited.

**Rule #5: Kanban Must Be Attached to the Actual Parts**

You already understand that kanban are a tool for visual control. At the production site, parts are always moving. Information must be attached to the actual parts and flow together. Otherwise, it is difficult to determine the whereabouts of various parts. If kanban are attached to actual parts, anyone can locate and trace them at a glance.

**Rule #6: The Number on the Kanban Must Agree With the Number of Actual Parts**

If the number on the kanban and the number of actual parts differ, it means that the preceding process is not producing parts in accordance with kanban instructions.

Inaccurate production of parts at the preceding process causes kanban discrepancy at the following process. This leads to a situation in which no one knows the reason for the discrepancy.

## Operational Trouble

If the rules of Process Instruction kanban or Parts Withdrawal kanban are not observed, the following problems will develop in sequence:

(1) The number of kanban with process instructions or withdrawal instructions will fluctuate.

(2) Certain parts will not be produced in the quantities required. This will result in a shortage of parts.

(3) Parts shortages will in turn cause an increase in the number of kanban issued.

(4) An increase in the number of kanban will lead to increased production of parts and a resultant increase in inventory.

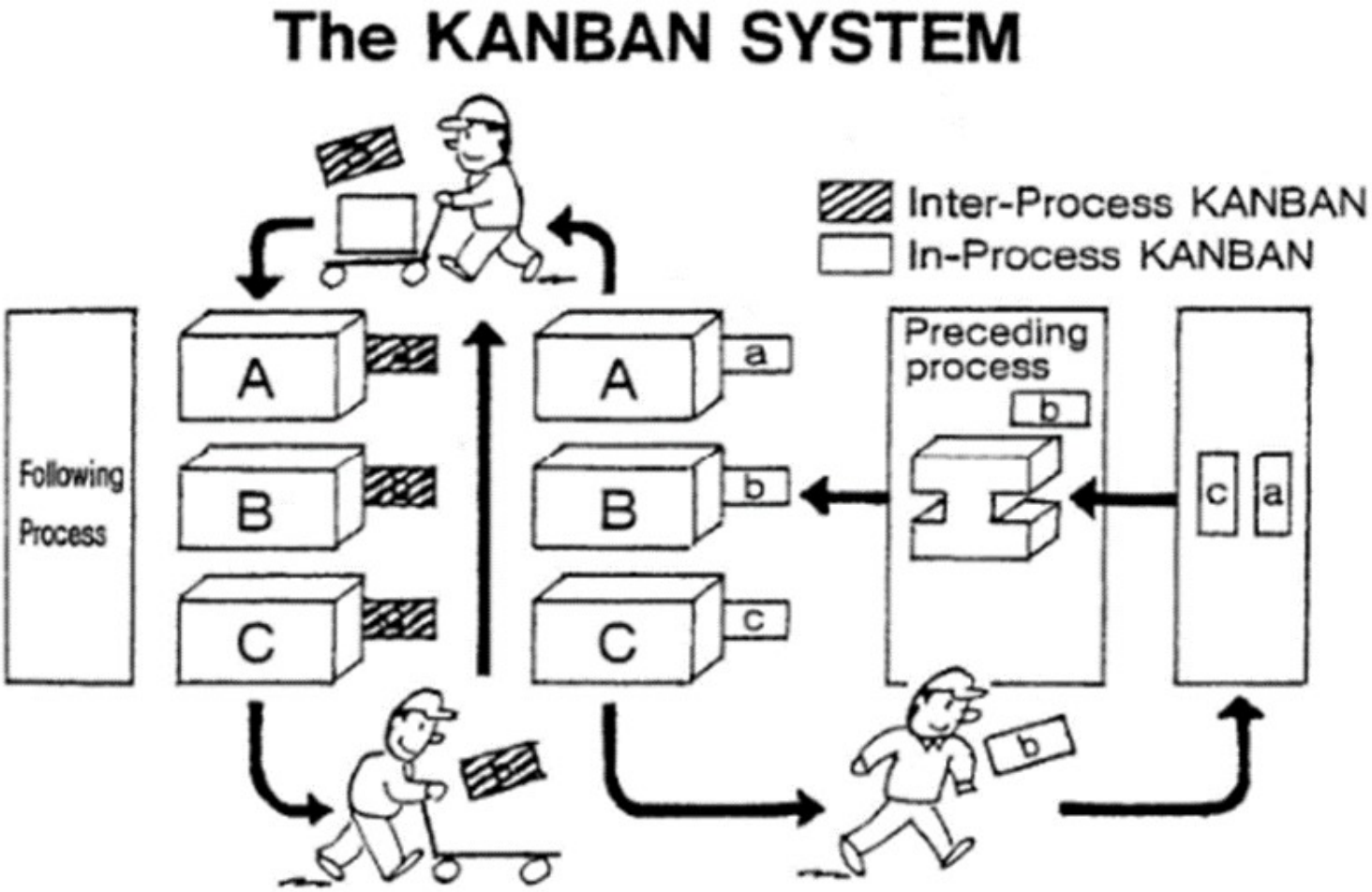
(5) Excessive inventory hides the root causes of problems, such as equipment trouble or violations of the kanban rules.

(6) This, in the end, diminishes the need and importance of continuous improvement and weakens the efficiency of the entire production system.

## Knowledge of Kanban

We've learned about the preconditions and role of kanban. Now, let's consider the various types of kanban.

Kanban fall roughly into two classes: PARTS WITHDRAWAL KANBAN - PRODUCTION INSTRUCTION KANBAN




A production line is a relationship between preceding and following processes.

The work of a preceding process has two functions:

- (a) to manufacture parts according to the kanban from the following process
- (b) to convey the completed parts to the following process

The separation of these functions provides instruction and parts withdrawal.

## Types of Kanban

Let's look at the types of kanban using concrete examples.

(1) Types of Kanban

Kanban are divided into two categories:

(A) Production Instruction Kanban and

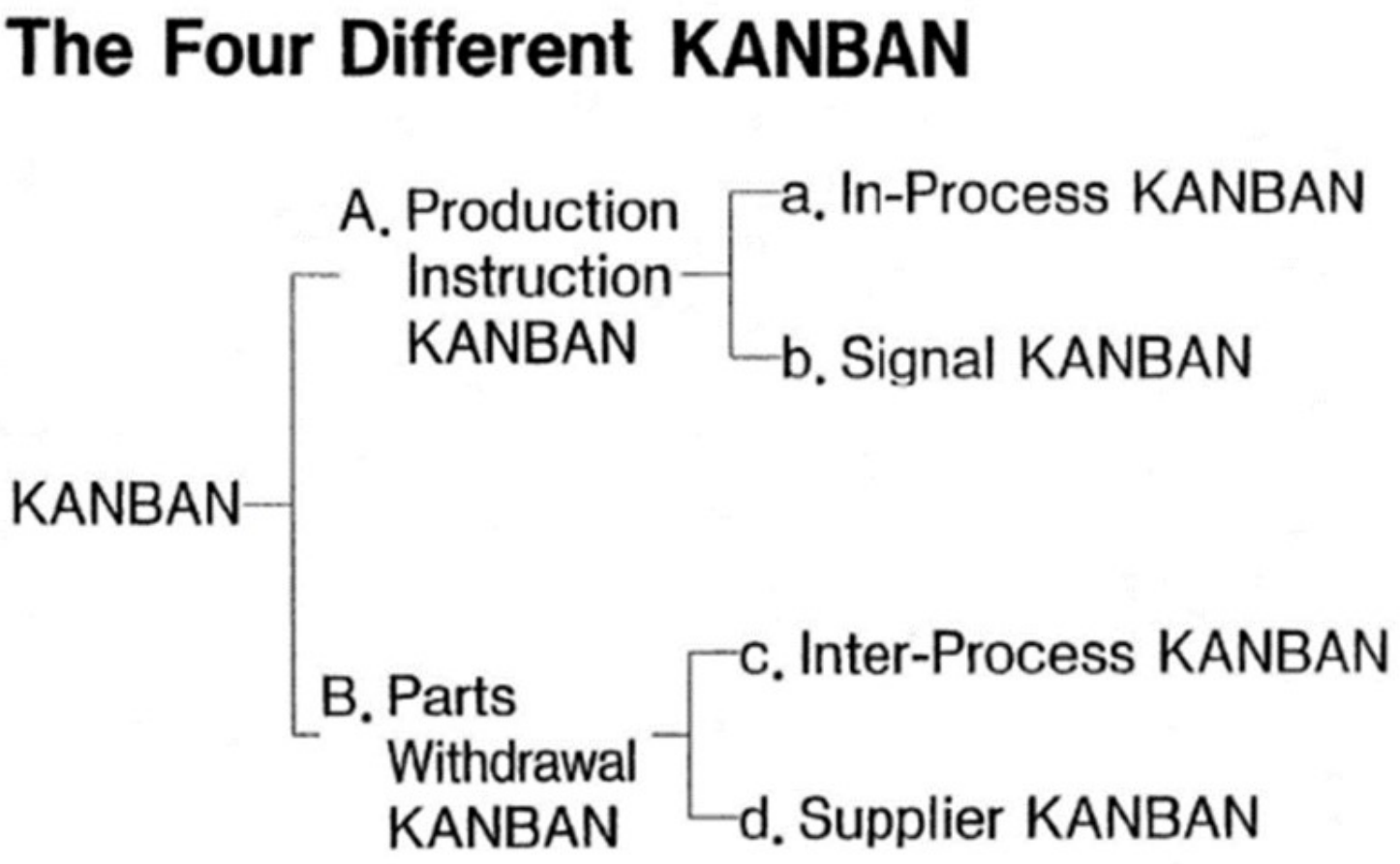
(B) Parts Withdrawal Kanban.

The Production Instruction Kanban are further divided according to type of process:

- (a) In-process kanban and
- (b) Signal kanban

The Parts Withdrawal Kanban are subdivided:

- (c) Inter-process kanban, which are used to convey parts between processes within Toyota plants, and
- (d) Supplier kanban, which are used between Toyota and a supplier.




## Examples of Kanban

**In-process kanban**

In-process kanban are used for set-up inside a process. They are used in assembly lines or in multiple-part production processes subject to short die changes. They are common in line production processes.

**Signal kanban**

Signal kanban are used in a single line or in a process where equipment, which machine is used to various kinds of parts, requires a somewhat longer time for die set-up changes. Signal kanban give set-up instructions in lot production processes. Because of their shape, they are typically referred to as "triangular kanban."

**Inter-process kanban**

In the assembly line, parts must be collected from many preceding processes, such as machining, pressing, painting, plating, resign forming, and so on. Besides the Production Instruction kanban needed to perform assembly line set-up, other instructional kanban are therefore needed to withdraw parts from the preceding processes. Inter-process kanban provide this type of instruction.

**Supplier kanban**

Supplier kanban are essentially the same as Inter-process kanban. The only difference is that the preceding process is an outside company.

## Operations

For the kanban system to operate efficiently, certain preconditions must be met. In addition, operational rules must be formulated.

Let's examine the following:

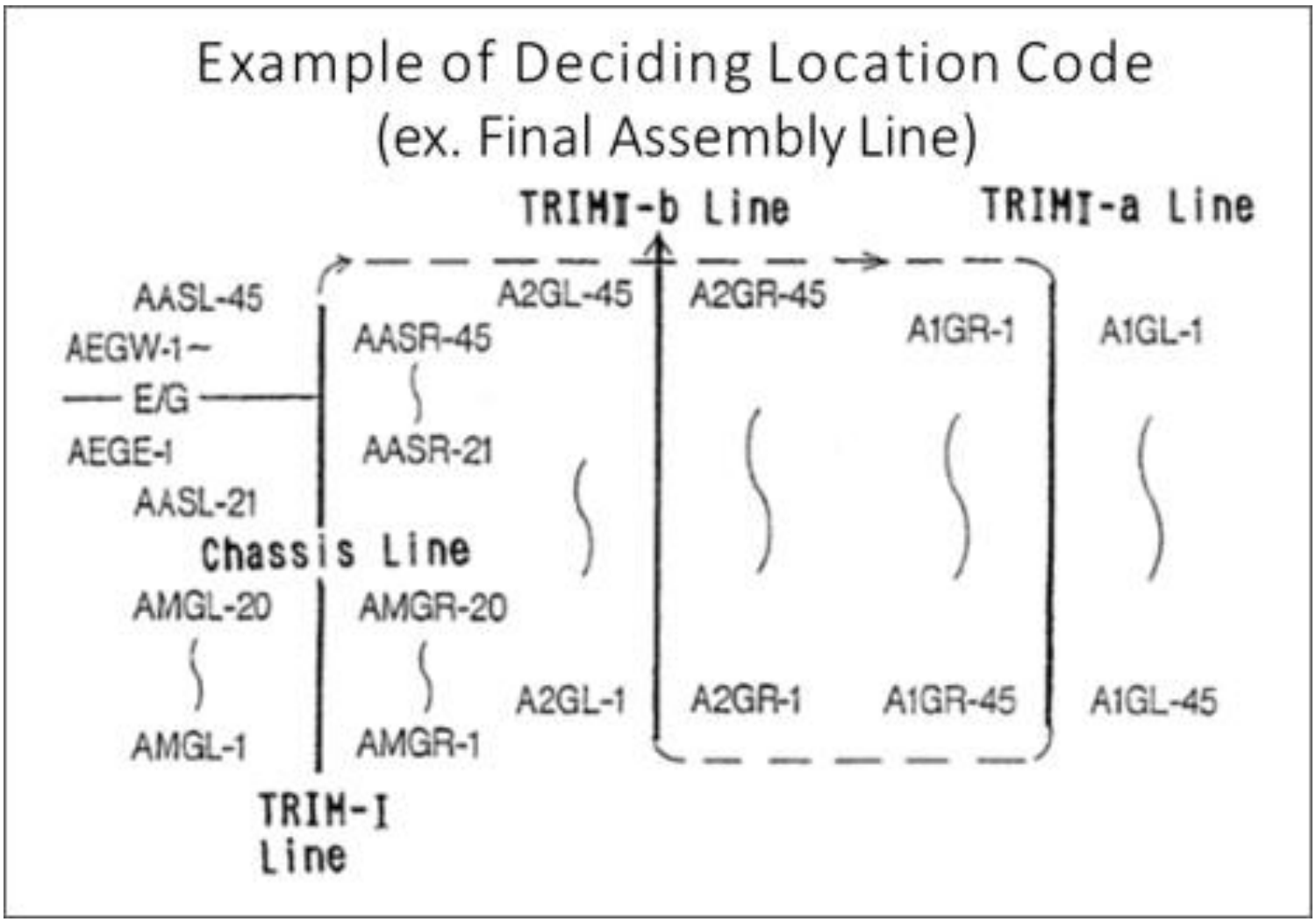
- (1) the Definition of the Parts Storage Area,
- (2) the Operational Method of In-process kanban and Inter-process kanban, and
- (3) the Operational Method of Signal kanban.

## Definition of the Parts Storage Area

i) Creation of Location Code and Management

An example of how the kanban addresses or location codes at the assembly line in the Takaoka Plant are organized.

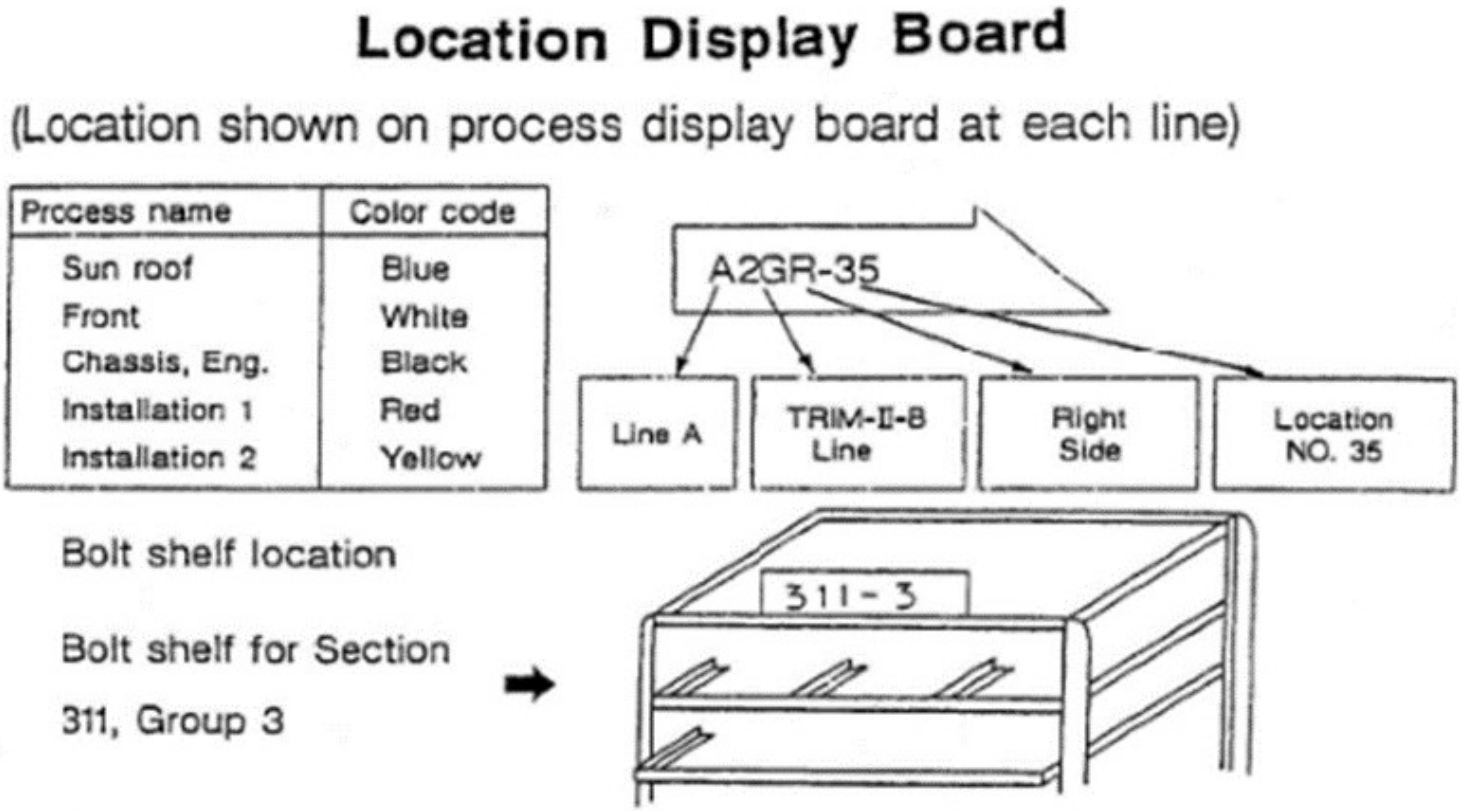
Assembly lines are divided according to the flow of the vehicle: TRIM I, CHASSY, TRIM Il-a and TRIM Il-b. Assembly is also divided into the RH side and LH side, and further subdivided with detailed numbering. Example of Deciding Location Code (ex. Final Assembly Line)




Example of an indicator plate. Note the location code: A line TRIM II-b, RH side, location code number 35.

The indicator plate uses color divisions to prevent misreading. Special shelving or flow racks are installed for small parts, so employees can readily locate them as needed.

This type of indicator plate makes it easy for anyone to find the location code or address. It simplifies parts conveyance, and eliminates the conveyance of the wrong parts and the shortage of the parts.




ii) Information Display on Flow Rack

the next example of flow rack display labelling on the assembly line side. Five types of information, numbered from 1 to 5, are written on the flow rack.

This information is as follows:

① The name of the storage area specified by a location code or address,

② The supplier's name,

③ A kanban number, or a 3-digit simplification of the part number

④ Kanban cycle

⑤ The total number of kanban issued

The first item of information, the storage area, must agree with the indicator plate location code or address mentioned earlier. The storage area must be displayed at each line and must agree with the storage area on the flow rack. If the parts storage area is changed, the flow rack display must be changed.

| ①A2GR-35 | | | | ④ 1-8-3 |
|---|---|---|---|---|
| ② Aishin | | ③ 76 | | |
| ⑤ Turnover rate | | | | ← Direction of flow |
| June | July | August | Sept. | |
| 4 pcs | 6 pcs | 5 pcs | pcs | |

| No | Item | Use/Remarks |
|---|---|---|
| ① | Storage location | Indicated at each line (Cross check Kanban and flow rack) |
| ② | Supplier's name | Manufacturer's name (Plant's name also should be entered) |
| ③ | Kanban no. | Indicated with numerals |
| ④ | Delivery cycle | No. of deliveries and lead time |
| ⑤ | Turnover rate | At month end, enter turnover for following month. Update whenever changed. |

The next example is of the shortage area on a flow rack at an assembly line. Labels are displayed on the shelves, the same parts are always put in the same places on the flow rack, thus preventing incorrect or missing parts.

Storage location

**A2GR-35**

| Storage location A2GR-35 | | | | Delivery Cycle |
|---|---|---|---|---|
| supplier: Aishin | | | | 1-8-3 |
| Turnover rate | | | | Direction flow |
| June | July | August | Sept. | |
| 4 | 6 | 5 | | |
| pcs | pcs | pcs | pcs | |

iii) Supplier kanban

This is an example of a supplier kanban for a radiator. One supplier kanban is attached to each container

with a given type of part. This type of kanban has Q items of information on it:

① location code or address,

② delivery frequency,

③ supplier name,

④ kanban number,

⑤ part number,

⑥ back number,

⑦ part name,

⑧ vehicle type and quantity,

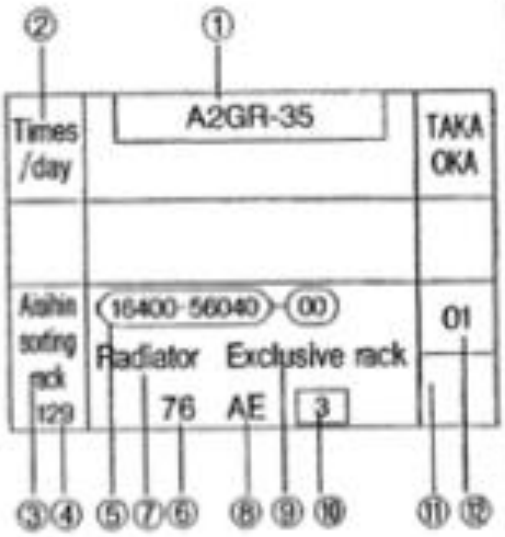
⑨ type of (rotated) box,

⑩ capacity,

⑪ storage area identification, and

⑫ receiving.

Any change in this information will require a review and change in the supplier kanban.




| No. | Item | Use/Remarks |
|---|---|---|
| 1 | Location | Parts place |
| 2 | Delivery frequency | Supply time and lead time |
| 3 | Supplier name | Supplieer company name and its initial mark |
| 4 | Kanban number | Instruct parts shelf number |
| 5 | Part number | Part number and identification color |
| 6 | Back number | Part number and abbreviation |
| 7 | Part name | Part name |
| 8 | Vehicle type and quantity | Supplimental information |
| 9 | Type of (rotated) box | Clarify box to use |
| 10 | Capacity | Quantity amount of parts per box |
| 11 | Storage area identification | Color distinction regarding conveyance route |
| 12 | Receiving | Instruction of receiving area |

## The Operation of In-Process Kanban and Inter-Process Kanban

Fig. 12 shows the circulation route of Inter-process kanban and the operation of In-process kanban using an example in which the preceding processes are process lines (A), (B), and (C) and the following process is the assembly line. As we mentioned earlier, process lines (A), (B), and (C) in the preceding process each have an inventory of completed parts, this is store ⑥. There's also inventory ⑦ on the assembly line side of the following process.

The In-process kanban are attached to boxes of a set quantity for each type of part in the store ⑥. Similarly, the Inter-process kanban are attached to stock in the line side storage area ⑦.

As parts in the assembly line store ⑦ are used up, the Inter-process kanban attached to the container is placed in the kanban post ①. At a certain specified time or when a certain specified remaining quantity has been reached, the Inter-process kanban are gathered, and the conveyance members go to the preceding process to pick up the parts as instructed on the kanban, taking the empty boxes. ②

The conveyance member goes to the completed parts ④ of process line A.

In actual use, the In-process kanban attached to the box of parts to be withdrawn is detached and placed in the Production Instruction kanban post ③ and the Inter-process kanban brought to the storage area is attached to the parts box. The parts are then ready for conveyance. Any returned empty boxes are placed in their specified locations.

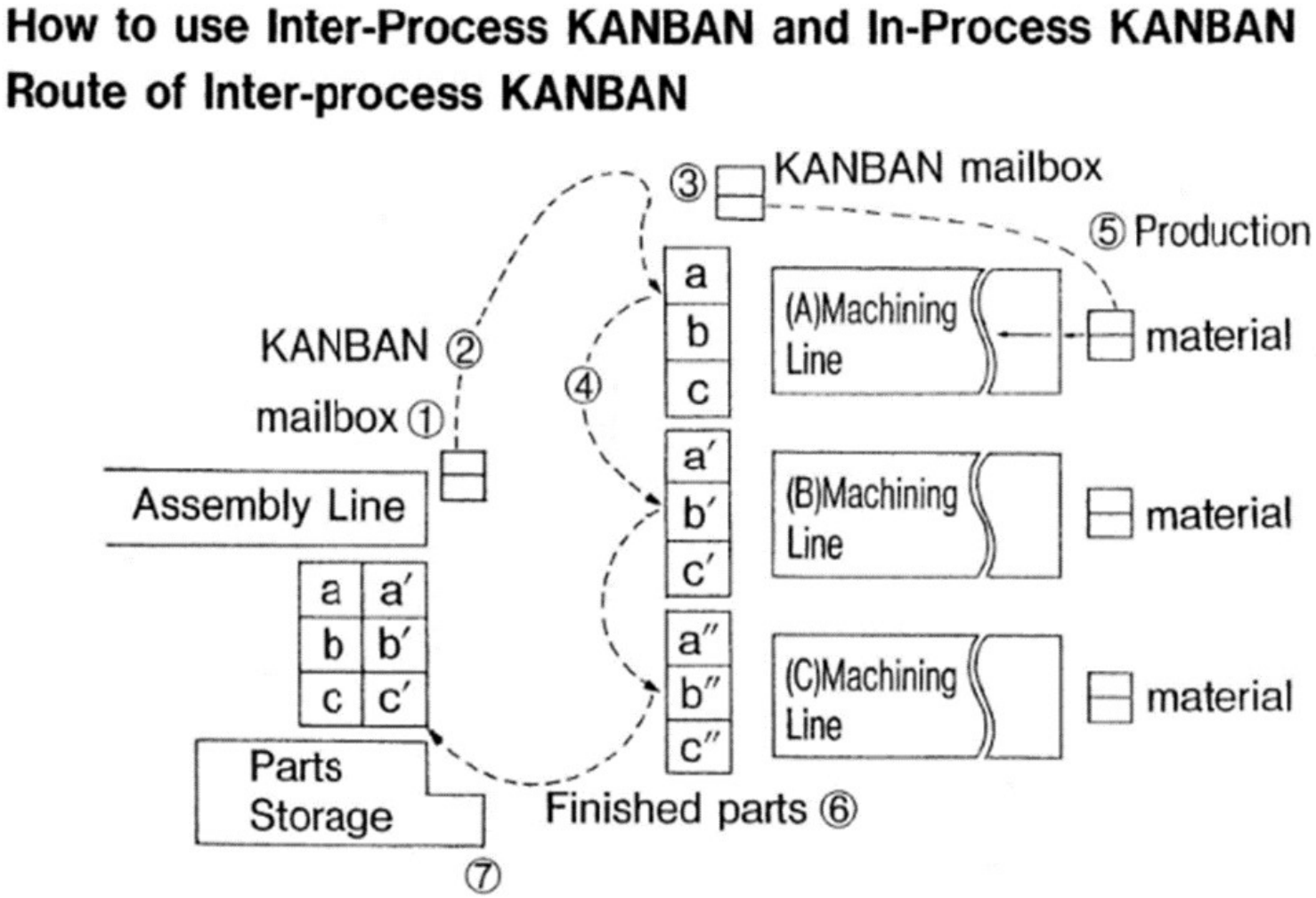
The conveyance members then go to the succeeding storage area and withdraws parts in the same way.

At the process line, team members produce as many applicable parts as are specified by the In-process kanban taken from the Production Instruction kanban post ③.

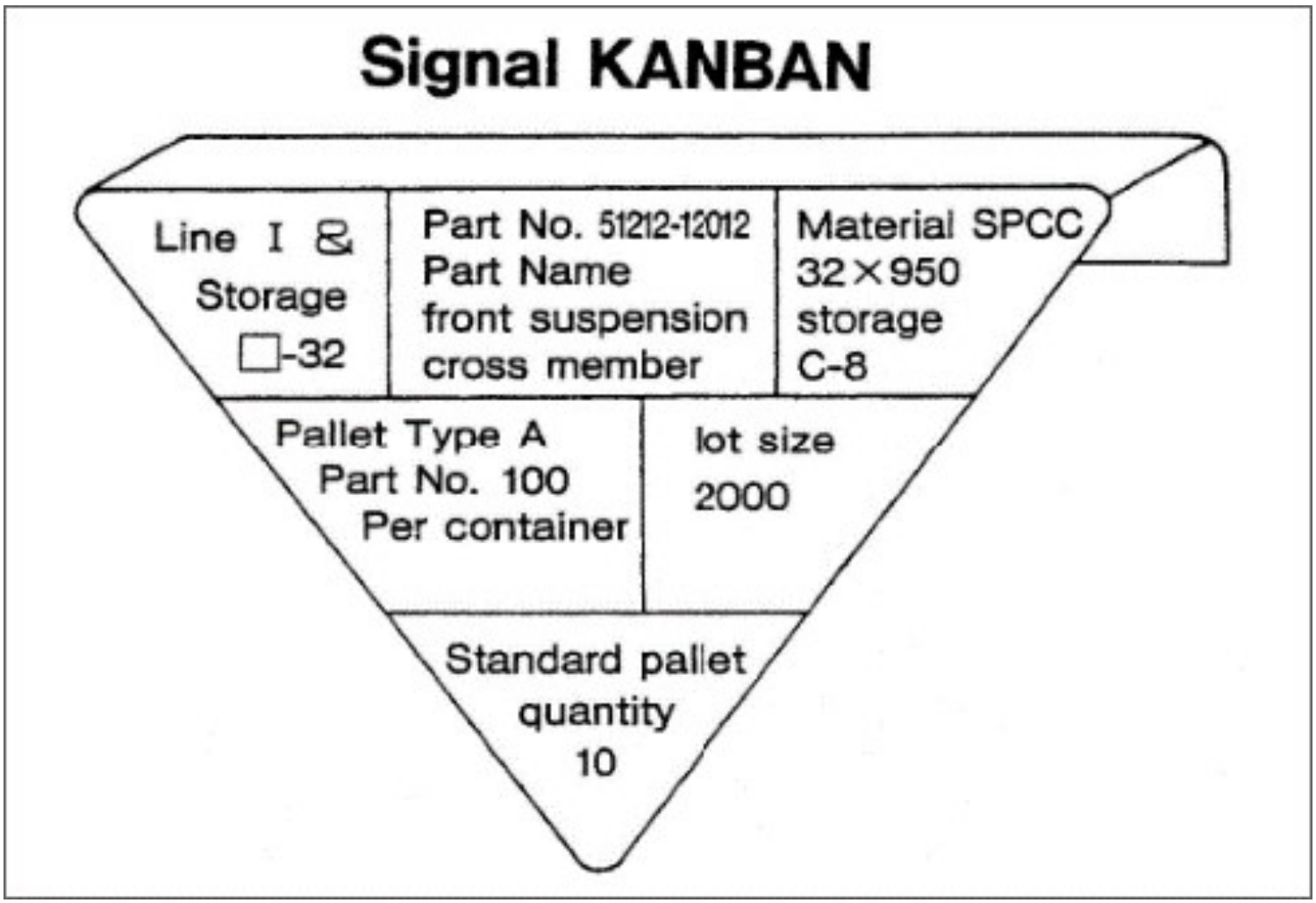
If there are multiple In-process kanban in the post, production at the process line must proceed in the order with which the kanban are placed into the post.

Even if several kanban call for the very same parts are in the past, these parts cannot be produced together in one large batch.

The In-process kanban flow down the process line with the parts and, after the parts indicated by the kanban have been completed, the kanban are attached to the parts boxes and the boxes placed in the storage area ⑥.




Operation of Signal kanban




i) Information of Signal kanban

① the stamping process name and the address of the storage area for stamping parts,

② the stamping part name,

③ the materials, dimensions, and the address of the storage area,

④ the name of the pallet for stamping parts that is, the assembled form and the capacity per pallet,

⑤ the processing quantity for one set-up change, that is, the lot size and

⑥ the order point.

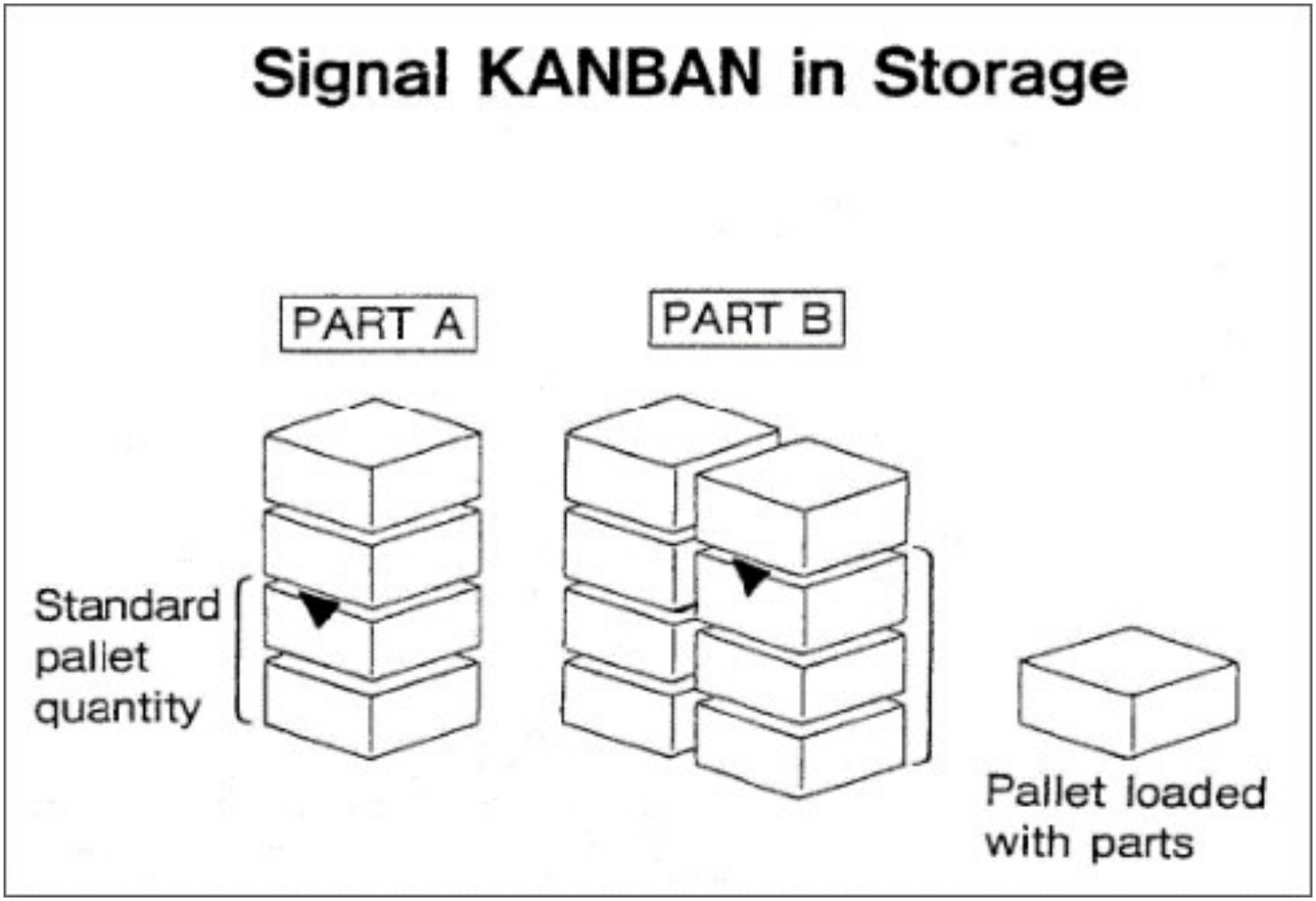
ii) Signal kanban and Storage

Signal kanban attached to pallets in the stamping storage area. Location codes ① and ② are clearly written for part types A and B.

There is one Signal kanban for each part type attached to the pallet indicating the order point. If the order point of parts A is 2, the Signal kanban is attached to the second pallet from the bottom. If the order point of parts B is 3, the Signal kanban is attached to the third pallet from the bottom.

If the conveyance member in the following process withdraws a parts pallet that has a Signal kanban, they

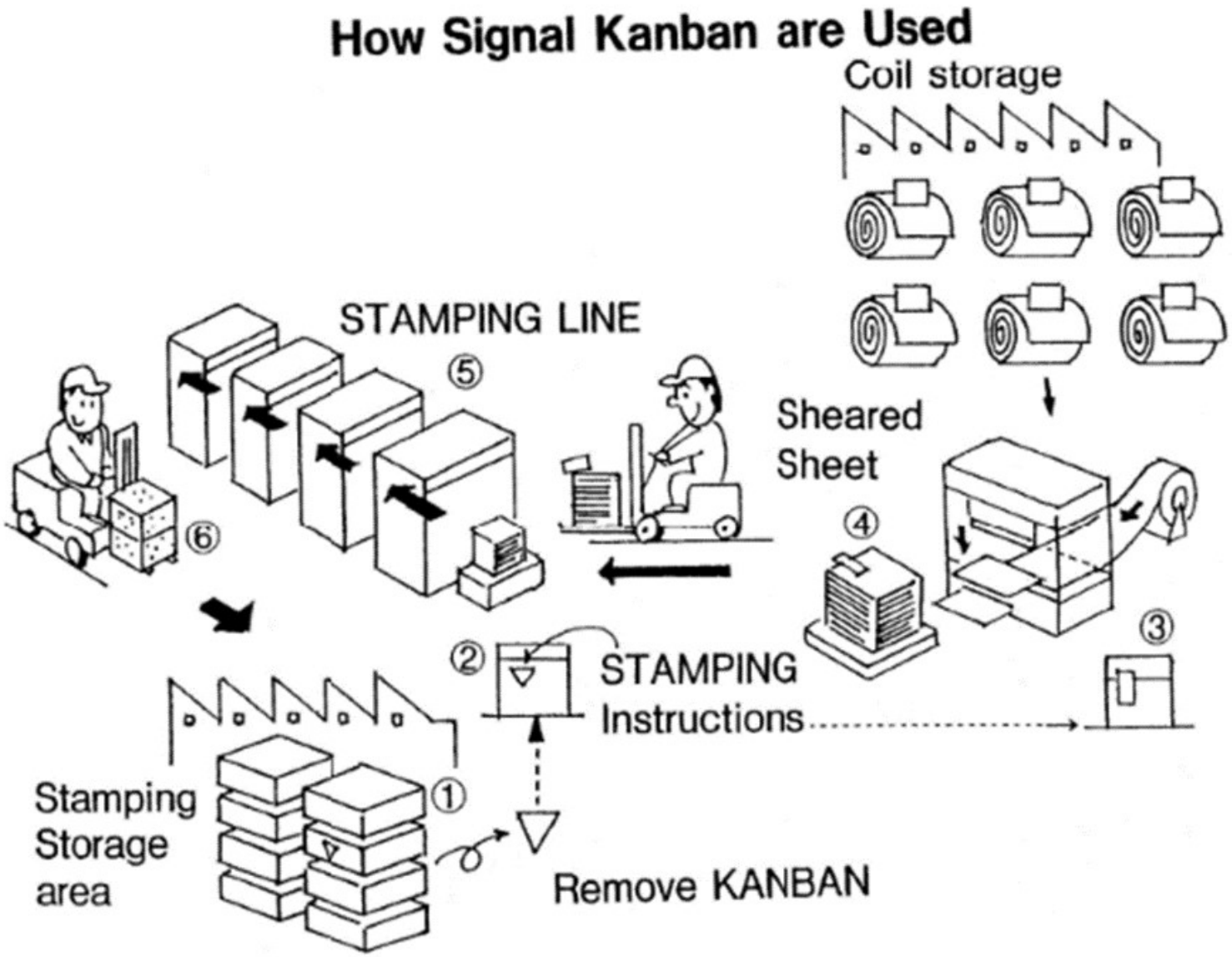
remove it and takes it to the stamping process where it provides production instructions to the process. [7]




iii) Operation of Signal kanban

The completed stamping process parts are reached in store ①. The conveyance member from the following process withdraws parts in pallet units. If he or she withdraws a pallet with a Signal kanban, he removes this signal kanban and takes it to the stamping process. At this point, instructions for coil shear are issued to the shear process. These instructions are called Coil Shear kanban.

The shear process works according to the kanban. Sheared iron plates ④ are conveyed to the stamping process ⑤. Stamped parts ⑥ are then placed in the stamping storage area ①. This cycle from ① through ⑥ is repeated as needed.




## Kanban Cycle and Kanban Numbers

### Kanban cycle

[Preconditions]

- The capacity of one box must be determined. The capacity of one box per part number should be constant.
- The delivery frequency and time must be determined.

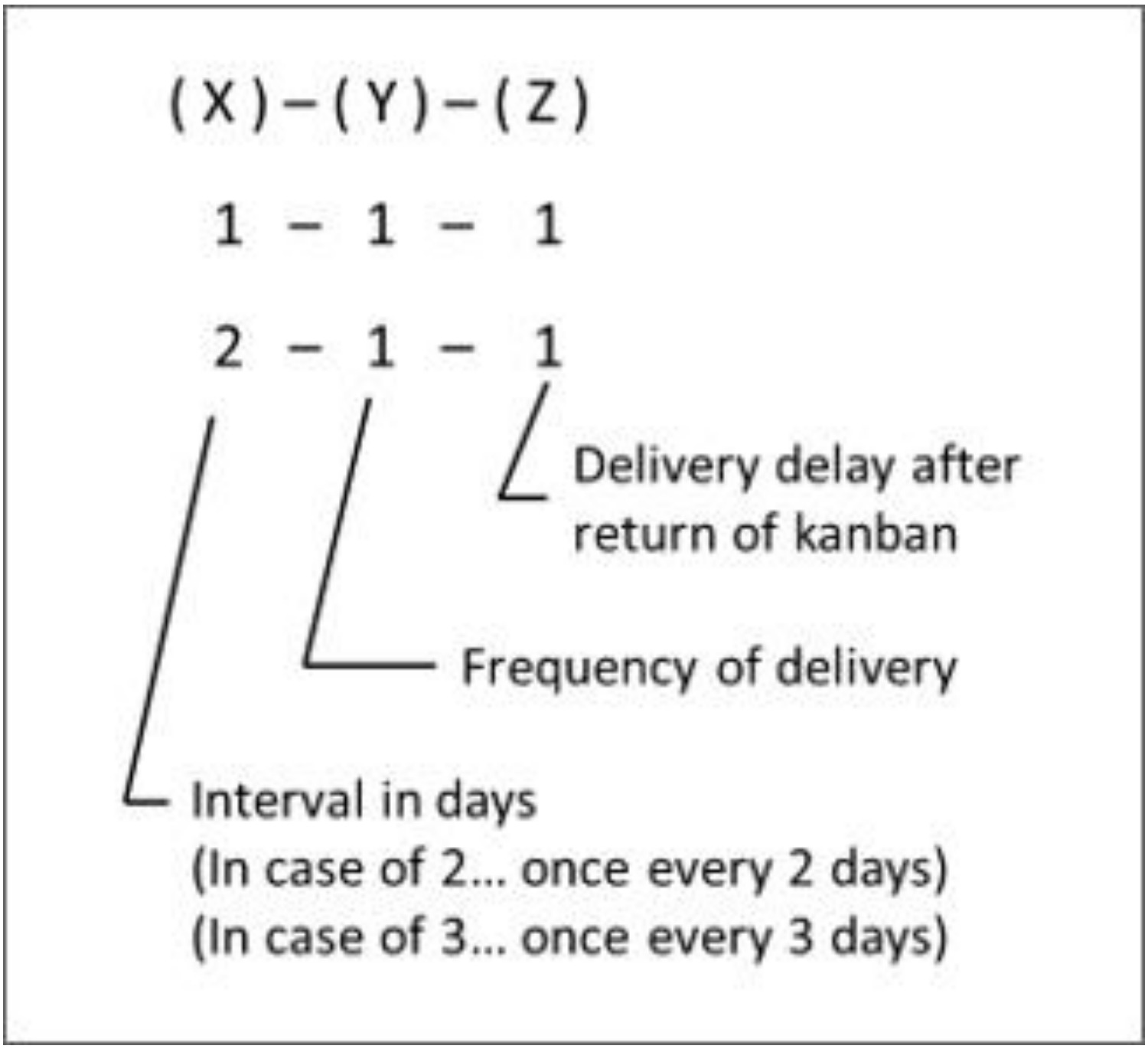
* The number of deliveries per day must be determined.

* The delivery interval must be constant, and both kanban withdrawal and delivery must be performed at the previously determined time.

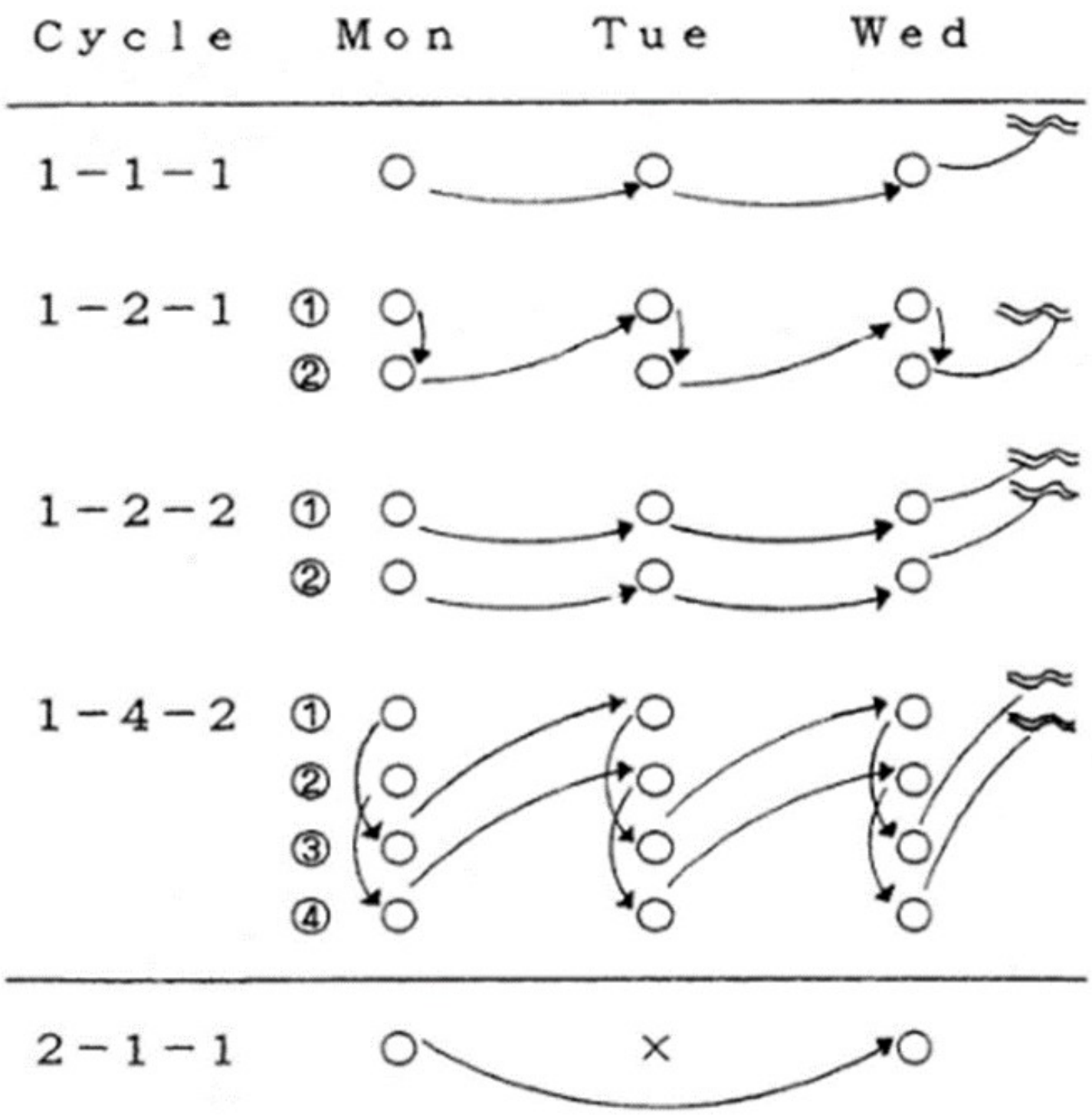
Kanban cycle

This is the delivery cycle that indicates the delivery frequency, and the number of cycles required for the parts to be delivered after the kanban has taken. The kanban cycle is marked as follows;

**Kanban Cycle**




Example of Kanban cycle: relation between delivery and receiving



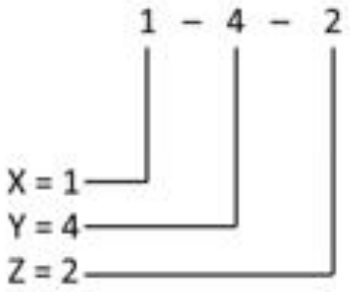

## Number of Kanbans and Calculation

The number of kanban is calculated based on the previously mentioned kanban cycle and on the assumption of the just-in-time system and the minimum inventory for that system.

$$\text{Number of kanban per cycle} = \frac{\text{Quantity used per day} \times (X) \times \frac{(Z)+1}{(Y)} + \text{Safety stock}}{\text{Capacity per box}}$$

Key: X, Y and Z are the kanban cycle's numeric values.

For example, assume the kanban cycle is:




Example of calculation

| | | |
|---|---|---|
| Kanban Cycle | 1 - 4 - 2 | |
| Necessary quantity per day | 1,200 | pieces |
| Capacity per box | 100 | pieces |
| Safety stock quantity | 200 | pieces |

$$\text{Number of kanban per cycle} = \frac{1200 \times 1 \times \frac{2+1}{4} + 200}{100}$$

## Adjusting the Number of Kanban Due to Changes in the Production Schedule

(1) Adjustment Operation

The operation of increasing or decreasing the number of kanban is performed by the manufacturing- department that is in^ daily contact with the movement of products.

(2) Adjustment Increments

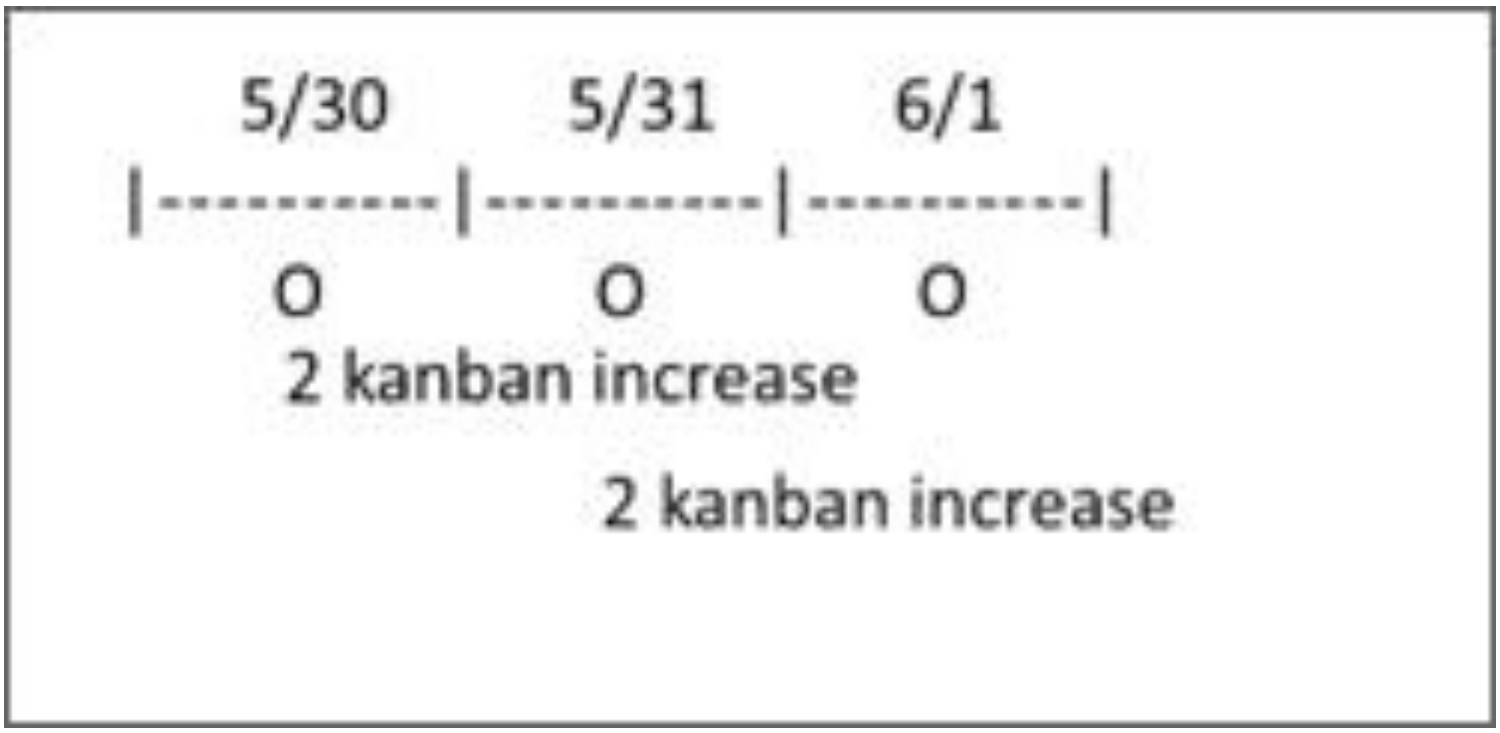
The increase or decrease in the number of kanban is performed in increments based on the (parts delivery cycle + 1) time.

Ex: Kanban cycle 1 - 2 - ② —> 2 + 1 = 3 times-.

If the adjustment is done all at once, the kanban will go to the preceding process and cause kanban irregularities.

(3) Adjustment Timing

Determined by the kanban cycle.



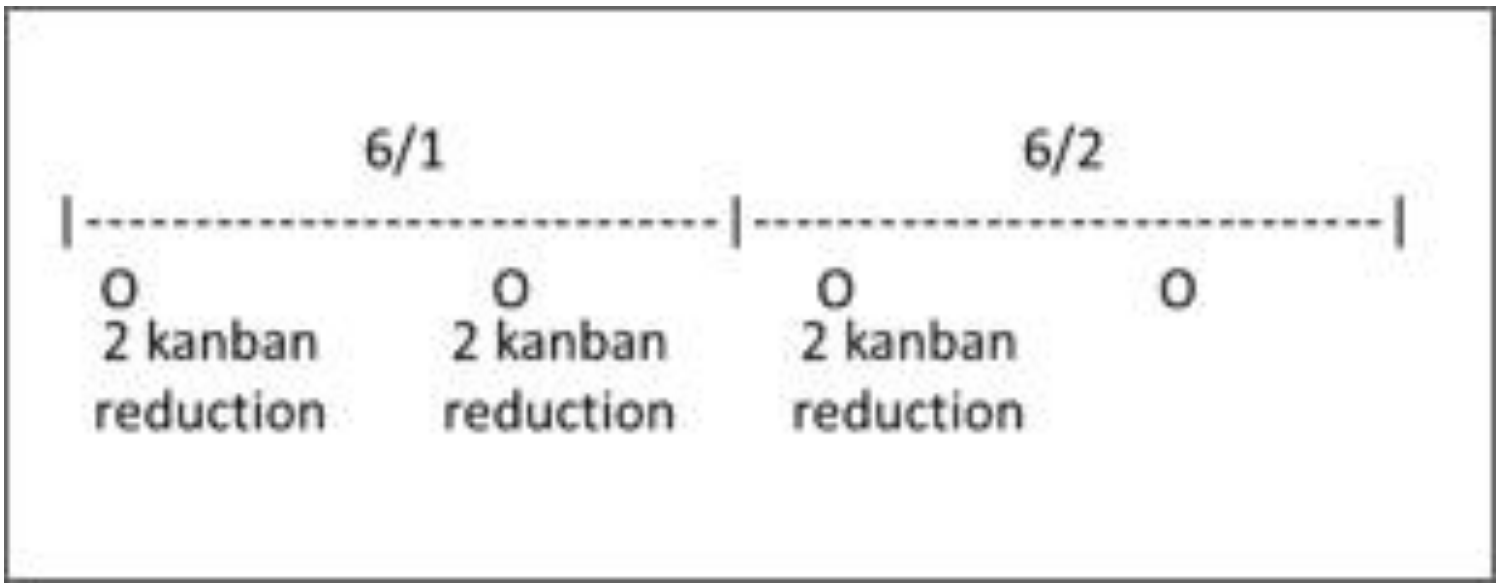

(**Ex-1**) If the production schedule is increased from the first day of the following month, stock must be increased just before the start of production on the first day.

Kanban cycle 1-1-1.

4 kanban increase

Increments = 2

2 kanban are added to the returned kanban on each of the two days preceding the increase.




(**Ex-2**) If the production schedule is reduced from the first day of the following month, stock must be reduced from the first day of the following month.

Kanban cycle 1 – 2 – 2

6 kanban decrease

Increments = 3

2 kanban are subtracted from the returned Kanban on first day.

## Cautionary Points in Operation and the Leader's Role

Summary of cautionary points in operating kanban.

- Adjustment of the number of issued kanban is performed in accordance with the date of the production schedule change. The process is mentioned earlier the item 3-4.
- Keep the safety margin for the number of issued kanban as small as possible by continuous improvement.
- Take out the kanban when used and collect them consistently at short intervals. (More than once a day.)
- Perform withdrawal of parts consistently and accurately.
- Always contact the Scheduling Staff when performing special production for temporary parts expenditure/usage. Issue temporary kanban consistently at short intervals. Collect the kanban quickly after use.

One must always keep leveled production in mind, move small numbers of kanban in short cycles, observe production level changes and maintain the number of kanban.

## The Leader’s Role

We've looked at the rules for operating kanban. Now, let's consider the leader's responsibilities which can basically be divided into three areas.

1. They should thoroughly understand the Toyota Production System. The leader should understand the premise and operational rules of kanban.

2. They should ensure that team members observe the rules. This is a job that requires a lot of patience.

3. They should educate and train new/regular team members. It is important to educate and to share information. Team members will learn best by actual practice and firsthand experience.

## Conveyance

Conveyance also plays a key role in the Just-In-Time production.

Let's consider the Toyota system of conveyance in the following order:

1. the purpose of conveyance,

2. the conditions and methods of conveyance,

3. the general rules of conveyance, and

4. examples of improvement in conveyance.

### The Purpose of Conveyance

The purpose of conveyance is divided into two objectives.

The first is to transport objects. In this case, large quantities should be loaded on large vehicles and carried at low cost. A regularly run truck is an example of such type of conveyance.

The second is to link isolated production processes in a timely way to achieve smooth production. In this case, the timing has priority over the loading efficiency. An example is conveyance between processes.

### The Conditions and Method of Conveyance

Let's review the conditions by which physically separate processes are linked more closely together to achieve smooth production.

**First**, production information from the following process must be conveyed to the preceding process frequently and swiftly. It ensures that the preceding process can react to the information with the proper production.

**Second**, the entire production process must put into effect maximum production with minimum inventory. This means the withdrawal of many kinds of parts. For example, if one truck conveys many kinds of parts, each process need maintain only a little stock and the truck can, along with the parts, convey regular information from the following process to the preceding process.

**Third**, stock in intermediate warehouses must be eliminated to reduce the expenses occasioned by storage and to produce parts with latest production information. This means the withdrawal of parts from the line-side parts storage area.

These principles of conveyance must be properly understood. This will ensure that team members understand the importance of their role in linking the separate processes of the production line.

## The General Rules of Conveyance

### Scheduled Quantity, Unscheduled Time Conveyance

This conveyance system follows the rule of the kanban system of conveying the necessary parts at the necessary time in the necessary quantities. In this method, the following process goes to the preceding process to withdraw parts when its scheduled quantity has been used up. This is based on consumption quantity and not on simple lapse of time. If a line stop occurs, therefore, the time until withdrawal will be prolonged by the time of stoppage. In general, in- house manufacturing conveyance within Toyota plants uses this method.

### Scheduled Time, Unscheduled Quantity Conveyance

This conveyance system is not based on the consumption quantity but on the elapsed time. If a line stop

occurs, the quantity of consumed parts will be lower depending on the time of stoppage and thus the quantity of parts withdrawn will also change. In general, this method is used in conveyance between remote locations for the delivery of purchased parts.

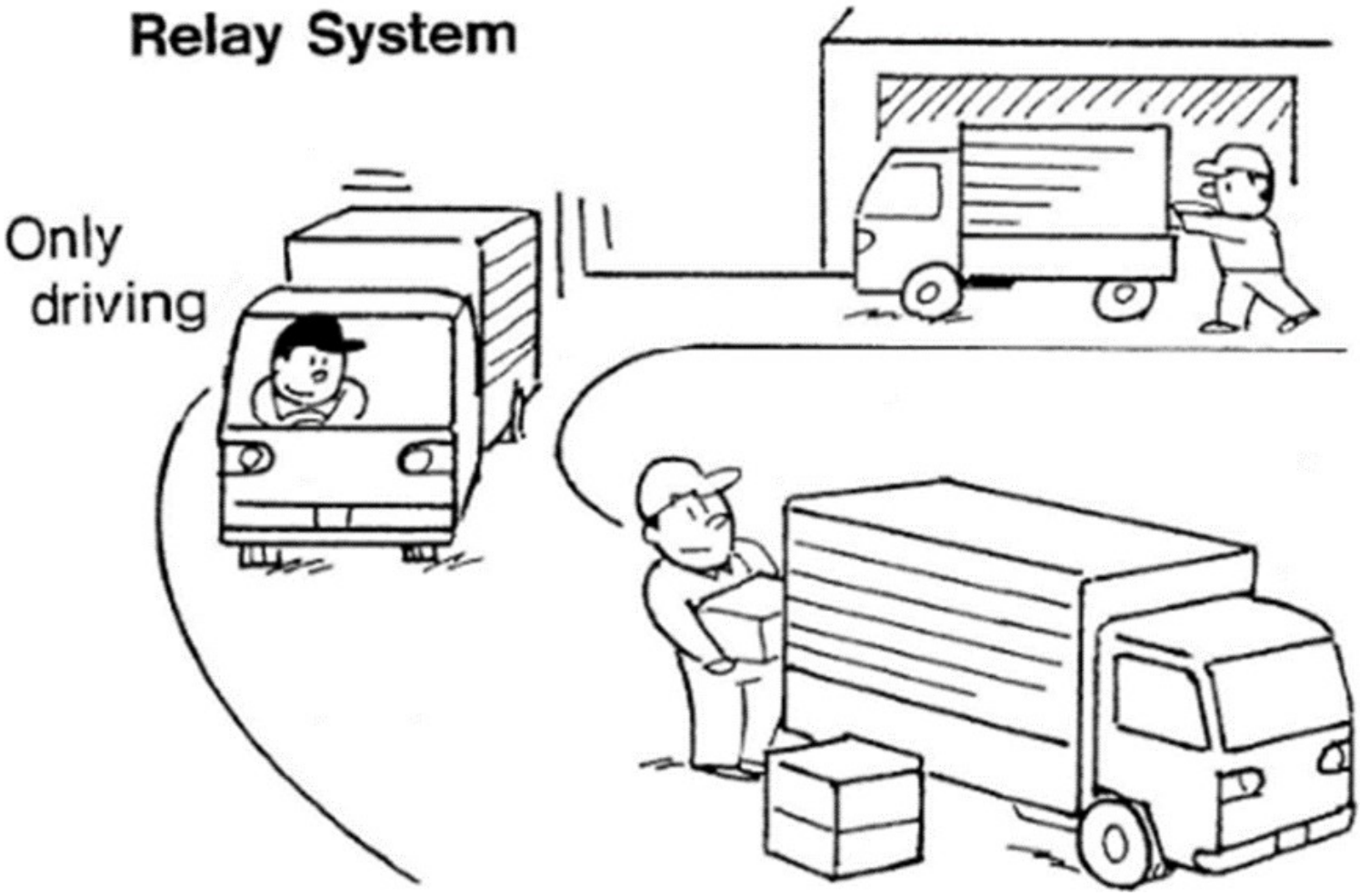
## Examples of Improvement

Let's consider a concrete example of continuous improvement.

### The Relay System vs. Normal Conveyance


Vehicles usually have dedicated drivers, and along their route they may load and unload or they may, in many cases, just wait during the loading and unloading operations.

Therefore, the loading and unloading work should be separated from the driving work so the driver with driving skill can devote all his energy to driving and display that ability to the maximum. This is the purpose of the relay method.




To achieve this relay method, vehicle transfer sites must be located at both ends of the conveyance route and a vehicle placed in each. As soon as the driver arrives after completing the specified driving route, he transfers to the other vehicle that has already been loaded and starts back on the route. Meanwhile employees unload the newly arrived vehicle and load it with parts before the next vehicle arrives.

The following result from this relay system.

1. Parts are loaded directly into the vehicle eliminating the need for a separate loading area.

2. Drivers spend their time driving not waiting for parts to be loaded. This increases the conveyance frequency per hour and reduces inventory in both the preceding and following processes.

3. Production information concerning' defective parts, delays, and so forth is more frequently communicated due to more frequent conveyance.

4. Drivers are driving, not waiting, therefore, the frequency of trips per person is increased. As a result, the cost per conveyance is reduced.

## The Kanban System in Support of the Order System

### The Order System

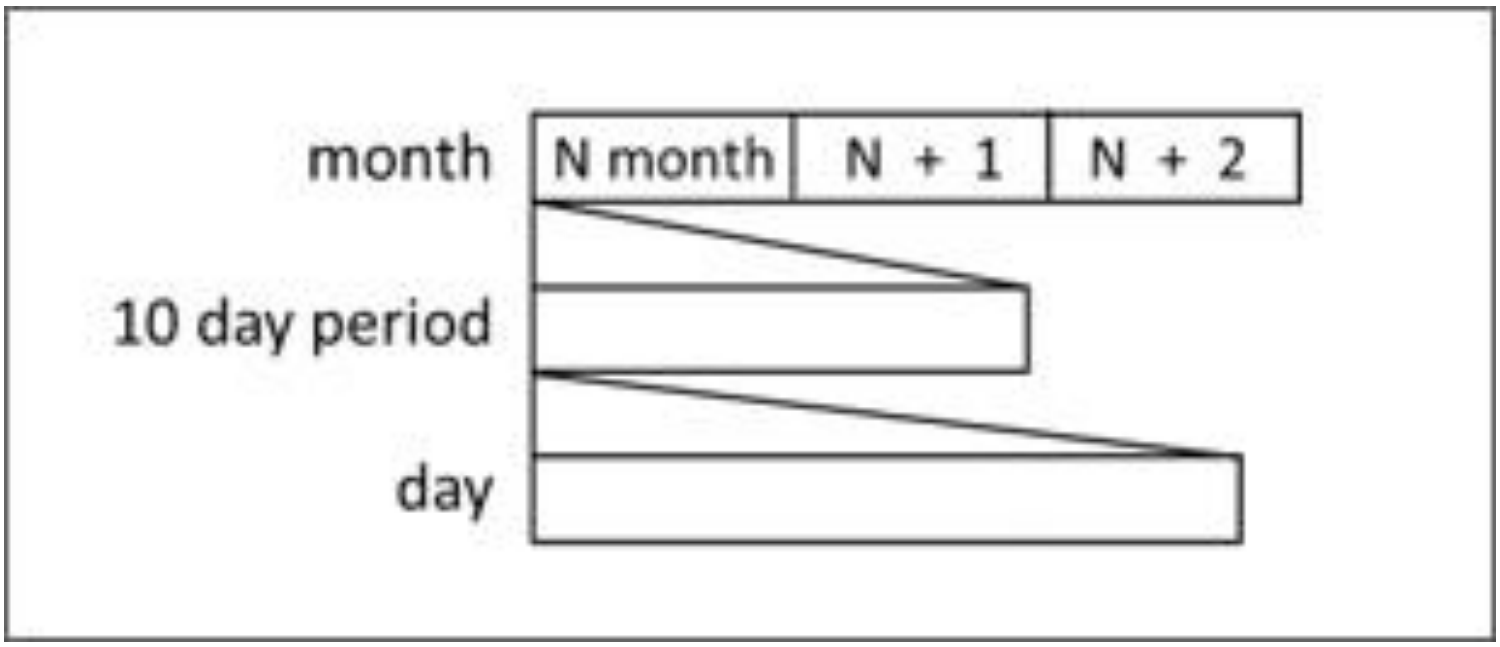
Now, after reviewing the kanban system let's examine how it fits in with the ordering process. The illustration below shows the Toyota Order System and its relation to the activity of producing parts.

The order system used by Toyota consists of three basic schedules:

- The monthly production schedule.
- The 10-day period schedule (Japan only).
- The daily order schedule (Japan only).

In Japan, we estimate the production schedule for the following month (N), N + 1 and N + 2 months based on the latest sales results. Outside Japan we fix the following month's production schedule based on the actual order from foreign dealers and then prepare a forecast of the production schedule for N + 1 and N + 2 months.

Depending on the demand trend, the total monthly amount will change but the monthly schedule is prepared so that production will be leveled daily. Equipment capacity must be considered when planning the schedule. The monthly schedule then determines the disposition of employees.



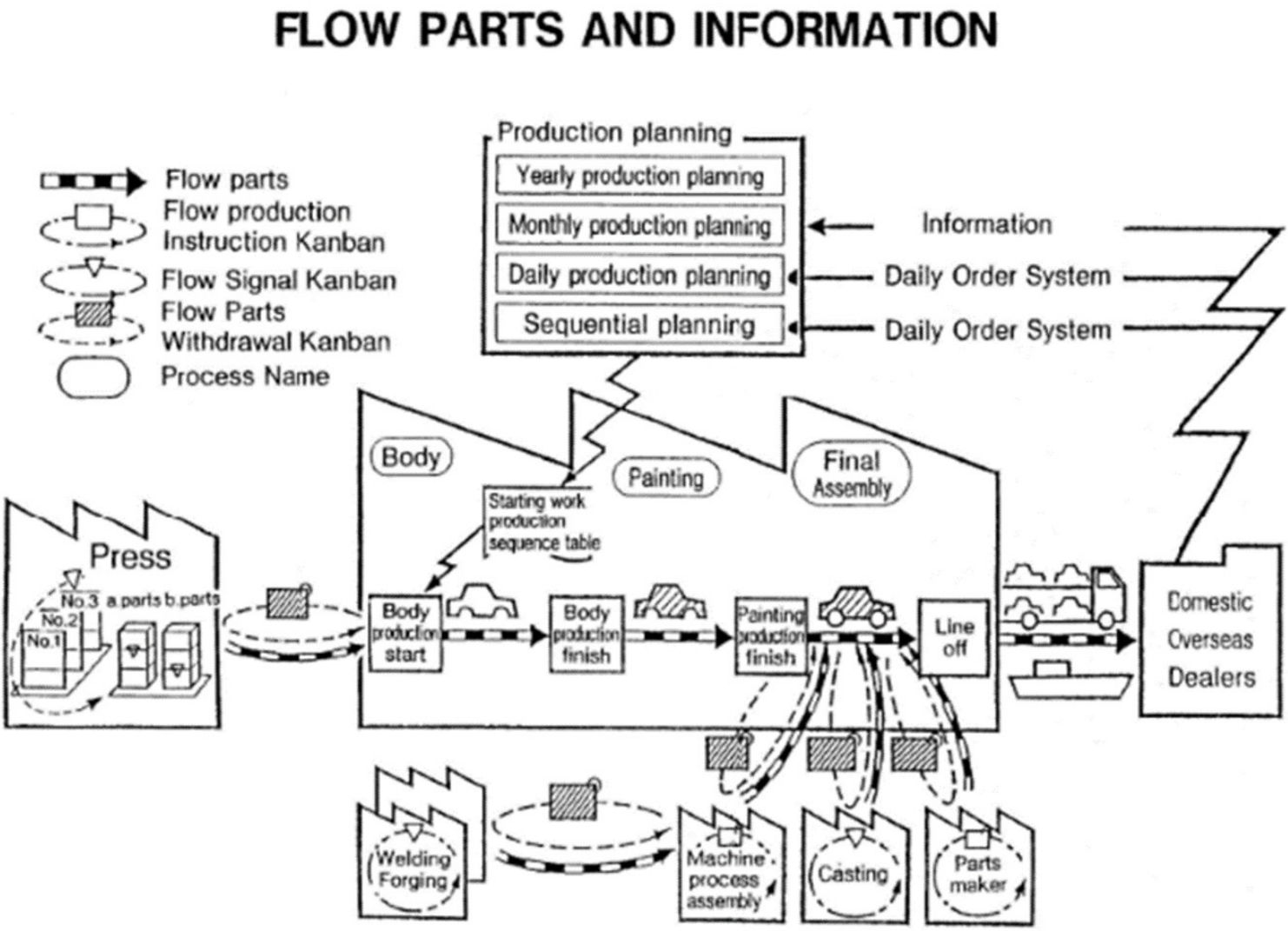

Based on the daily leveled monthly schedule, the required quantity of parts is calculated. This information is then conveyed to suppliers and to the appropriate places in the plant. The plant (or supplier) uses this information to recognize the difference in production amount between the previous month and the future. The number of circulating kanban for that month is calculated and adjustment is made in the number of those currently circulated. This preparation for production is done in cooperation with the actual work site.

The 10-day period schedule is next, but it has no relation to the production work site. The purpose of this schedule is to level out orders from domestic dealers daily. The plant uses it to inform the dealers of the expected delivery date.

The daily order schedule is last. This is a system in which the domestic dealers can make daily vehicle order changes to the 10-day schedule depending on customer demand. But it has a serious liability: since the production site must organize the team based on the leveled monthly schedule, changes in the daily schedule tend to interfere with production. Therefore, the order amount for daily changes is limited to a certain range. This range is the kanban fine adjustment that was previously mentioned.

As mentioned above, the order system can itself operate kanban smoothly.

## Flow of Parts and Information




## The Production Process

Toyota uses a fill-up production system regulated by kanban. The leveled schedule flows from:

**body —> painting —> final assembly**

Production instructions for stamping needed to complete the body and production instructions for parts – such as in-house manufactured parts, units and purchased parts — needed in assembly are issued by Production Instruction kanban.

The kanban system encompasses not only the production site but all companies that are engaged in automotive production, including the suppliers.

## The Wide Variety of Specification Types Desired by our Domestic Customers (Reference)

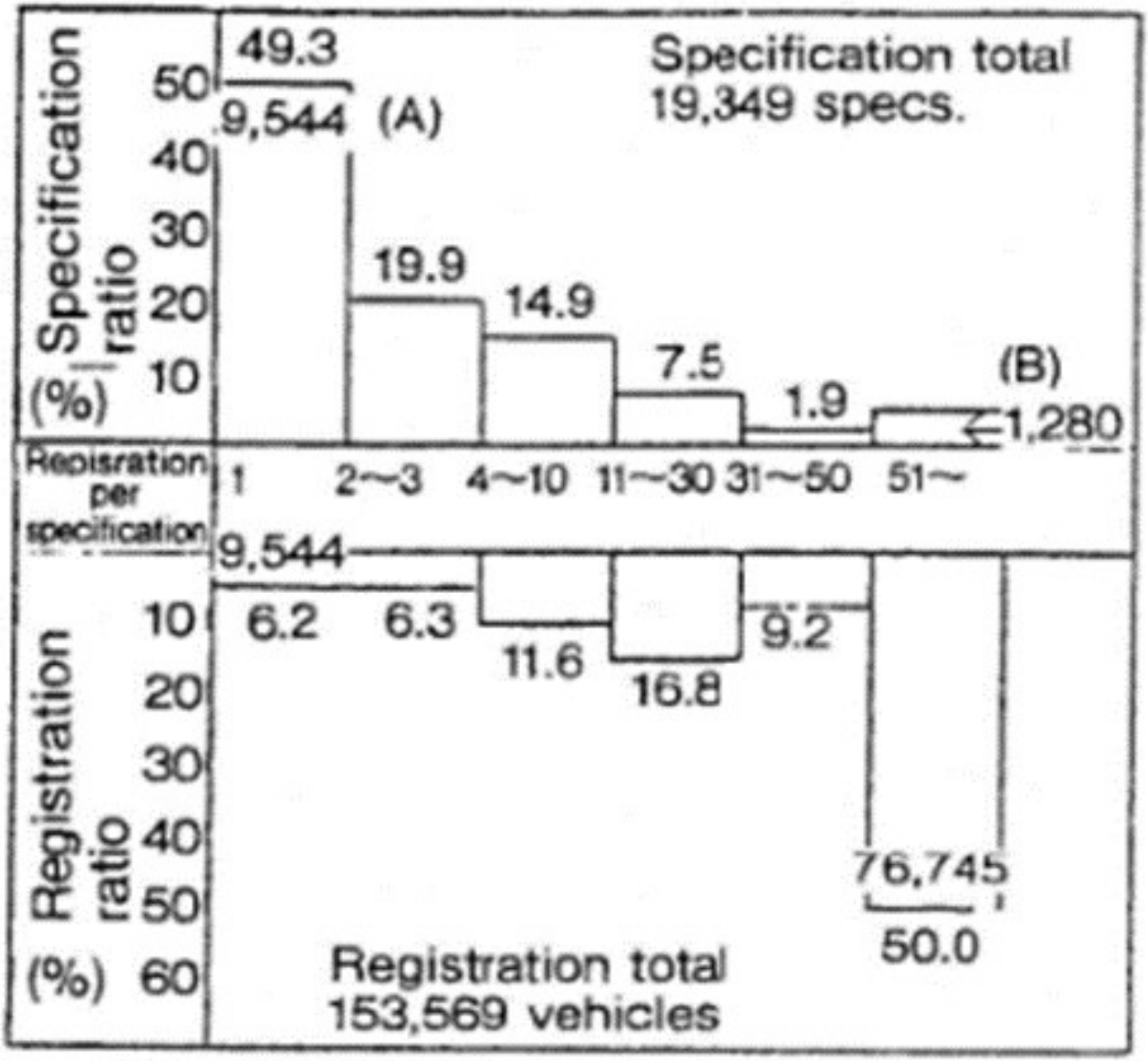
This Table shows Toyota's domestic automotive sales volume for a given one-month period and the number of vehicle types (given combination of specifications).

The total number of cars registered is 153,569. This consists of 19,349 different specification types. The X-

axis represents the number of vehicles sold per specification. The Y-axis represents the ratio of specification categories to the total number of specifications.

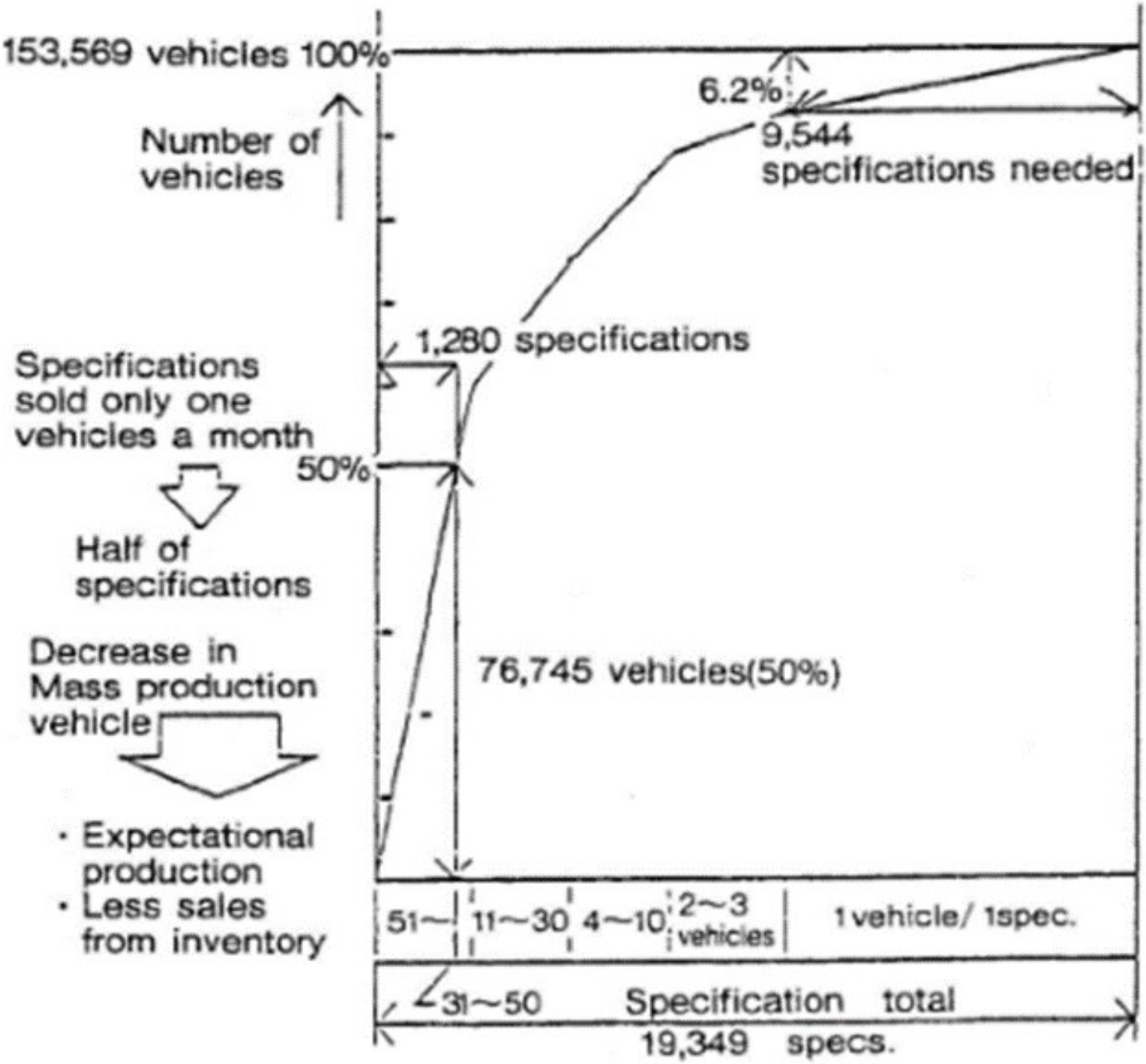
The lower portion of the chart shows the ratio of specification categories and the total number of vehicles sold.

- Explanation with Example A




Of the total number of specifications (19,349), 9,544 were one type (time) only sales. Specifications that sell only one car per month occupy almost half of the total number of specifications; this number is 6.2 percent of the total number of vehicles sold.

- Explanation with Example B




Of the total number of specifications (19,349), 1,280 were sold (requested/ordered) 51 times or over. Specifications that sold 51 or more per month occupy only 6.6 percent of the total number of specifications; this is 50% of the total number of vehicles sold.

Toyota's domestic sales of a month: The number of vehicles and specification

At a glance, it may appear that cars are all about the same. But each vehicle is made up of a wide variety of specifications. Under these circumstances, depending on estimates of production and sales, this may lead to excess inventory or the manufacture of unsalable vehicles. The result is not correctly matching production and demand. This is not a good situation for the company.

The data here demonstrates the importance of manufacturing vehicles in accordance with the Just-In-Time philosophy. Producing vehicles at the right time in the right amount is the goal of the Toyota Production System.

[1] The Kanban system is a fixed inventory system where quantities are defined by velocity of use, variability of delivery, quality issues, and shipping / handling considerations.

By 1915, Ford's Highland Park plant had a defined inventory system that was limited by space, bins, conveyor slots, etc. Plus, no paper transfer order was issued unless you got into safety stock. Then an '*expedite*' ticket was issued to prioritize production of parts. (Like a kanban card.)

[2] Inventory is used as insurance to make sure they can meet production demands.

[3] This is the objective... to reduce disruptions.

[4] Kanbans are calculated on velocity + reliability + variation; the approximate minimum inventory to avoid disruptions. It can still hide problems.

[5] Taiichi Ohno had a rough guideline of reducing variation below about 5% before a Kanban system would be useful.

[6] Flow Principle #4 – Balance work demand -->Heijunka. The sales and marketing departments have more impact on loading of the production than the actual production department, as they are the ones that take the customer's order and set the promised delivery dates.

[7] The signal kanban location has the lead time for the order processing factored in: Transport of signal to process, Queue of kanban at process (average), Setup time required, Run time for minimum (1 kanban quantity), Transport time, Receiving time, Transport to line location - Lead time is a function of the system velocity

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