**KANBAN SYSTEMS**

Andrew Kusiak  
Intelligent Systems Laboratory  
2139 Seamans Center  
The University of Iowa  
Iowa City, Iowa 52242 - 1527  
Tel: 319 - 335 5934  
Fax: 319-335 5669  
andrew-kusiak@uiowa.edu  
http://www.icaen.uiowa.edu/~ankusiak

---

**Contents**

- **INTRODUCTION**
- **JUST-IN-TIME CONCEPT**
- **MODELING KANBAN SYSTEMS**
- **MODIFIED KANBAN SYSTEMS**
- **SUMMARY**

---

**What is JIT?**

- A management approach  
- Producing only what is needed, at the time it is needed, and the amount needed  
- An integrated management system  
- JIT’s mandate: *Eliminate waste*  
- “Kanban systems” - an example implementation strategy of the JIT concept

---

**Examples of Waste**

- Idle machine run  
- Waiting for parts  
- Counting parts  
- Overproduction  
- Moving parts over long distances  
- Storing inventory  
- Looking for tools  
- Machine breakdown  
- Rework

---

**Elements of JIT**

- Pull production concept  
- Flexible resources  
- Cellular manufacturing  
- Kanban production control  
- Small-lot production  
- Quick setups  
- High quality  
- Supplier networks

---

**Pull vs Push System**

**Push**

- Forecast driven  
- Larger lot sizes (based on EOQ)  
- Fast response to changes in production demand

**Pull**

- Demand driven  
- Small lot sizes  
- Slow response to changes in production demand
Kanban Systems

*Lost its glamour?*

The first kanban system was applied by Taiichi Ohno in Toyota around 1953 to:

- Reduce inventory and production cycle time
- Improve productivity

---

Kanban and Kaizen

Kanban - a card (Japanese term)

vs

Kaizen - continuous improvement
- a concept different than Kanban
- problem solving by teams

---

Push vs Pull Concept

<table>
<thead>
<tr>
<th>Push system</th>
<th>Pull system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production plan</td>
<td>Production plan</td>
</tr>
<tr>
<td>Stage 0</td>
<td>Stage 0</td>
</tr>
<tr>
<td>Stage 1</td>
<td>Stage 1</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Stage 2</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Stage n (Final)</td>
<td>Stage n (Final)</td>
</tr>
</tbody>
</table>

Schedule

---

Scheduling Kanaban Systems

- Each stage has its 'own schedule' of kanbans
- This schedule is determined at the kanban system design stage
- Production is indirectly scheduled by kanbans

Pull system

Production plan

Schedule

Schedule

Schedule

Schedule

---

Kanban Control System

- Kanban card indicates standard quantity of production
- Derived from two-bin inventory system
- Kanban maintains discipline of pull production

---

Kanban Control System

- Once implemented, a Kanban system acts a control system rather than a scheduling system
- It implements a repetitive schedule embedded in the system
- This schedule can be generated by a scheduling algorithm
- Simulation can be used to determine the number of kanbans, queue size, etc.
Example Kanban

<table>
<thead>
<tr>
<th>Part No:</th>
<th>7412</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Slip rings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Box capacity</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>From: Machining M-2</td>
<td></td>
</tr>
<tr>
<td>Box Type</td>
<td>A</td>
</tr>
<tr>
<td>Issue No.</td>
<td>3/5</td>
</tr>
<tr>
<td>To: Assembly A-4</td>
<td></td>
</tr>
</tbody>
</table>

The General Kanban System

Op1: When demand from stage \( i +1 \) occurs, withdraw a kanban and place it on the dispatching board.
Op2: Production activity initiates when a kanban is placed on the dispatching board.
Op3: Simultaneously, demand is sent to stage \( i -1 \).
Op4: Completed parts with kanbans are sent to stage \( i +1 \).

Dual Kanban

Production kanban - a card authorizing production of goods
Withdrawal kanban - a card authorizing the movement of goods

Each kanban is physically attached to a container

Basic Kanban Rules

Rule 1: Move a Kanban only when the lot it represents is consumed.
Rule 2: No withdrawal of parts without a Kanban is allowed.
Rule 3: The number of parts issued to the subsequent process must be the exact number specified by the Kanban.
Rule 4: A Kanban should always be attached to the physical parts.
### Basic Kanban Rules

Rule 5: The preceding process should always produce parts in the quantities withdrawn by the subsequent process.

Rule 6: Defective parts should never be conveyed to the subsequent process.

Rule 7: Process the Kanbans at every work center in the order in which they arrive at the work center.

### Dual Kanban System

1. Process B receives a production kanban. It must produce enough of the items requested to fill the empty container to which the production kanban is attached.

2. Process B uses a container of input items and generates a request for more items from the preceding workstation (process A).

3. The request for more items takes the form of a withdrawal kanban sent to preceding workstation (process A).

4. Since process A has the items available, the withdrawal kanban is attached to the full container and immediately sent to process B.

5. The production kanban that originally accompanied the full container is removed and placed on the empty container, therefore generating production at process A.

6. Production at process A requires a container of input items. Process A uses a container of input items and generates a request for more input from preceding workstation. The request for more input items takes the form of a withdrawal kanban sent to the preceding workstation.

### Basic Preconditions for Kanban Systems

- Repetitive production in small lots
- Balanced manufacturing system (capacity balancing model)

### Balanced System

<table>
<thead>
<tr>
<th>Station</th>
<th>Flow 1 = Flow 2 = Flow 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Load 1</td>
</tr>
<tr>
<td>S2</td>
<td>Load 2</td>
</tr>
<tr>
<td>S3</td>
<td>Load 3</td>
</tr>
</tbody>
</table>

### Flowshop

Is kanban system a jobshop or flowshop?

Flowshop
Production Balancing

Before production balancing

<table>
<thead>
<tr>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/30</td>
<td>B/30</td>
<td>C/30</td>
</tr>
</tbody>
</table>

Production balancing

<table>
<thead>
<tr>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>150%</td>
</tr>
<tr>
<td>100%</td>
</tr>
<tr>
<td>50%</td>
</tr>
</tbody>
</table>

After production balancing

<table>
<thead>
<tr>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
</tr>
</tbody>
</table>

Balanced System

<table>
<thead>
<tr>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
</tr>
</tbody>
</table>

Functions of Kanbans

- Visibility function
- Production function
- Inventory function

Kanban Squares

Marked area holding limited number of output items

Flow of work
Flow of information

Kanban Racks

To hold a limited number of items (e.g., 1 or 2)
Signal Kanban

Resembles the reorder point system (order components when inventory drops below the safety level)

Determining Number of Kanbans

Number of kanbans =
Units daily demand x Order cycle time x Safety factor / Lot size

Units daily demand = the daily production rate of the part
Order cycle time = the time it takes to process the part
Lot size = the number of parts authorized by the kanban

Example

Number of kanbans =
Units daily demand x Order cycle time x Safety factor / Lot size

400 units per shift
.2 shift per part
lot size of 20 parts
Number of kanbans = \( \frac{400 \times .2 \times 1.5}{20} = 6 \)

Classification of Kanbans

1. Primary kanban: travels from one stage to another in a main manufacturing cell or production preparation area
2. Supply kanban: travels from a warehouse or storage facility to a manufacturing facility
3. Procurement kanban: travels from outside of a company to the receiving area
4. Subcontract kanban: travels between subcontracting units
5. Auxiliary kanban: may take the form of an express kanban, emergency kanban, or a kanban for a specific application
The University of Iowa
Intelligent Systems Laboratory

**Production kanban**

- Product name
- Part code
- Preceding stage
- Succeeding stage
- Card no.

SNP: standard number of parts

**Supply kanban**

- Due date
- Card no.
- Part code
- Part name
- Supplier name
- SNP
- Package type
- Inspection location
- Warehouse location

**Procurement kanban**

- Part no.
- Part name
- Storage location
- Supply location
- Supply package type
- Card no.

**Auxiliary Equipment**

1. Kanban box: to collect kanbans after their withdrawal.
2. Dispatching board: in which kanbans from the succeeding stage are placed in order to display the production schedule.
4. Supply management system: a system to manage the supply of raw materials.

**General kanban control system**

**Summary**

**Types of kanban systems**

- Single kanban system (using production kanban)
- Dual kanban system (using production and withdrawal kanbans simultaneously)
- Semi-dual kanban system (changing production kanbans and withdrawal kanbans at intermediate stages)