Gantt chart Simulation based Job Change Planning for LCD Industry

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Abstract. Minimizing job change leads maximizing utilization. To minimize job change, the efficient job change plan is needed. But the process of job change is very time-consuming and hard to consider various constraints such as job change crew, work in progress (WIP), tool and availability of equipment. In this paper, the simulation of constructing the Gantt chart for efficient job change planning in LCD industry is proposed as it is called Gantt chart simulation (GCS)

Keywords: Simulation, Gantt chart, Job Change Planning

1 Introduction

In electronic industries, a large number of product types are produced concurrently, 24 hours a day and 365 days a year, and there exist various constraints. Also jobs may be batched if they share the same setup on equipment [3]. As a job change(J/C) can be defined as a situation when equipments require setups if they are to process jobs that have differing characteristics [3], it is important to utilize equipments fully by minimizing job change. The lead time for a batch through the shop floor is made of four major components, the setup time, the processing time, transportation time, and the queuing time [1]. In order to maximize throughput and reduce the lead time, efficient job change is a big challenge in order to minimize job changes.

In real shop floor, a foreman who plans job change considers various constraints such as number of job change crew, work in progress (WIP), tool, and availability of equipment in planning. The process of job change is a very time consuming and hard to consider all constraints and then exceptional handling are required when the arrangement is not reflected all constraints.

Gantt chart is a graphical representation of the tasks and resources needed to complete a job or project. It may show ranges of possible start and end dates and the relationships between tasks [4]. Most people use a Gantt chart in planning and the Gantt chart is very useful and flexible to evaluate and edit the plan. In this paper, the simulation of constructing the Gantt chart for efficient equipment arrangement in process industries is proposed as it is called Gantt chart simulation (GCS) A Gantt block that is a basic model of Gantt chart simulation is defined with its operations and then the framework of Gantt chart simulation and its detailed algorithms are described. Also given in this paper is an illustrative application example that is implemented the GCS as a daily planning system in a tire industry. As the proposed framework is quite general in that the Gantt chart is very flexible, it might be suitable for process industries such as FAB.

Basic models of Gantt chart simulation and its operations are given in the next section, and the framework of GCS with detailed algorithm is presented in Section 3. An application example is given in the Section 4 and conclusion and discussion is provided in the final section.

2 Concept of Gantt chart Simulation

The basic concept of GCS is the simulation of constructing the Gantt chart using basic blocks. To simulate the Gantt chart, it is necessary to define a simulation model which represents basic elements of the Gantt chart and constraints that are needed to construct the Gantt chart. The operations of the simulation model are also defined.

2.1 Basic model of Gantt chart Simulation

Basic element of Gantt chart and the constraints such as equipment availability, crew availability and WIP availability are defined.

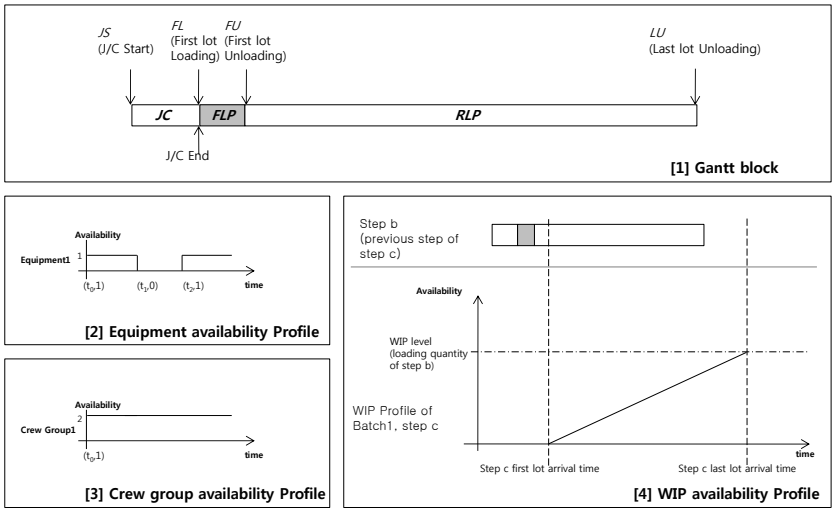

Fig. 1. Basic model of GCS

2.1.1 Gantt block (G) Gantt block is a basic element which constructs the Gantt chart. The Gantt block has time information and arrangement information.

$$G = (JS_G, FL_G, FU_G, LU_G, lQ_G, lF_G, lB_G, lS_G, lE_G) .$$

where

JS_G: J/C Start time of *G*

FL_G: First lot Loading time of *G*

FU_G: First lot Unloading time of *G*

LU_G: Last lot Unloading time of *G*

lQ_G: loading Quantity of *G*

lF_G: loading Flow rate of *G*

lB_G: loading Batch of *G*

lS_G: loading Step of *G*

lE_G: loading Equipment of *G*

Lot is a basic unit of transfer and loading flow rate is a production quantity per hour in the Gantt block. The loading flow rate is defined as

$$lQ_G / (LU_G - FL_G) .$$

In the Gantt block, some activities such as JC (Job Change), FLP (First Lot Processing) and RLP (Remaining Lot Processing) can be defined. The Gantt block does not contain idle time. That is, the Gantt block does not represent starving of equipment. Starving condition is represented by several Gantt block

2.1.2 Equipment availability Profile (EP) Equipment availability Profile (EP) shows availability information of the equipment with time. EP consists of Equipment-Segments (ES) which have same equipment id.

$$ES = (E_{ES}, EG_{ES}, T_{ES}, A_{ES})$$

where

E_{ES}: Equipment id of *ES*

EG_{ES}: Equipment Group of *ES*

T_{ES}: Time of *ES*

A_{ES}: Availability level of *ES*

The ES is created when the equipment loads or unloads a block. It contains equipment id, equipment Group, loading or unloading time of the block and

availability level of equipment with the time. Availability level has 0 when T is loading time, 1 when T is unloading time.

2.1.3 Crew availability Profile (CP) Crew availability Profile (CP) shows availability information of J/C crew with time. CP consists of Crew-Segments (CS) which have same crew group.

$$CS = (CG_{CS}, T_{CS}A_{CS})$$

where

CG_{CS}: Crew Group of *CS*

T_{CS}: Time of *CS*

A_{CS}: Availability level of *CS*

The CS is created when the J/C starts or ends. It contains crew group information, start or end time of J/C, availability level of crew with the time.

2.1.4 WIP availability Profile (WP) WP shows accumulated quantity with time which arrives from previous step to this step. WP consists of WIP-Segments (WS) which have same batch id and step id

$$WS = (lB_{WS}, lS_{WS}, F_{WS}, T_{WS}, A_{WS})$$

where

lB_{WS}: loading Batch of *WS*

lS_{WS}: loading Step of *WS*

F_{WS}: Flow rate of *WS*

T_{WS}: Time of *WS*

A_{WS}: Availability level of *WS*

The WS is created when the lot from previous step starts to arrive in this step and when the lot ends arrival. The A_{WS} represents accumulated quantity with the time. The F_{WS} represents arrival rate from previous step and it is same with flow rate of previous step.

2.2 Basic Concept of Gantt chart simulation

Gantt chart simulation concept is constructing Gantt chart of EQP using Incoming WIP Profile. First, the WIP Profile is initialized, according to the profile, Consuming Profile is constructed. Creation of Consuming Profile means constructing Gantt chart.

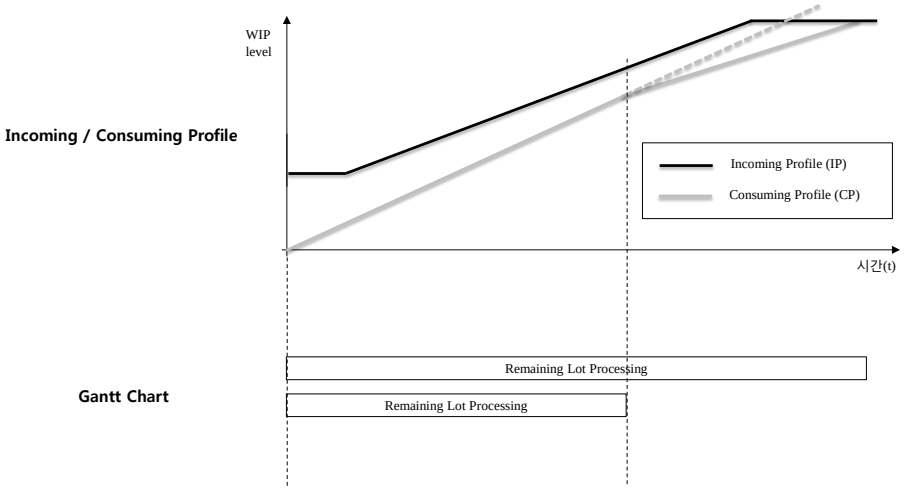

Fig. 2. Concept of Gantt chart simulation

3 Application: LCD VI Job Change Planning

In this section, application of GCS to LCD Industry is introduced. VI (Visual Inspection) process in LC FAB is target process. VI process has some constraints and count of the equipment is more than 10. VI Job Change Plan is created by foreman at every shift. It takes 30minutes to 1 hour.

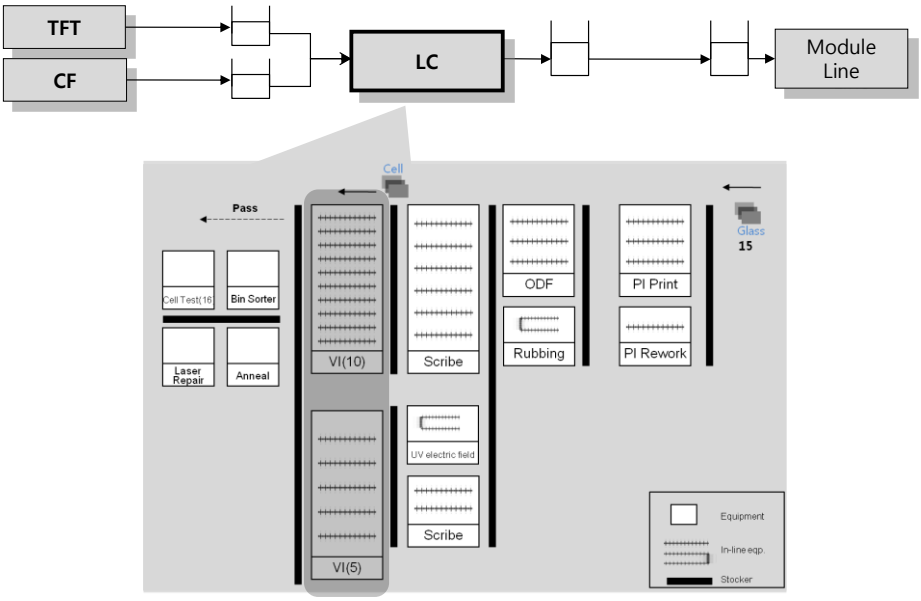

Fig. 3. LC-FAB Layout

Table 1. GCS Information

Category	Information	Description
Input	Release Plan	Release plan of PI process which is first process in LC FAB
	WIP	WIP State of processes
	EQP Loading State	Loading device information of equipments
Reference	BOP (Bill Of Process) of Devices	Sequence of processes
	EQP Standard Information	Setup time, tact time, flow time of equipments
Constraints	J/C Crew Information	Job Change Crew which executes Job Change
	EQP Loadable Relation	Loadable information between device and equipment

3.1 Basic Operation in VI job change planning

Basic operation of VI Job Change Planning is following

3.1.1 Allocation If WIP is accumulated more than specific values, available EQP is additional assigned.

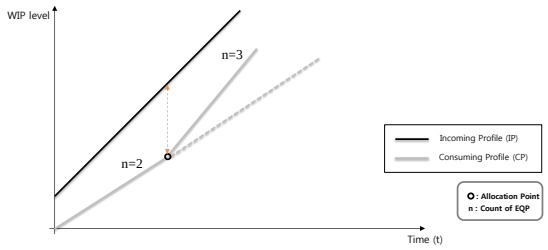

Fig. 4. Allocation

3.1.2 Release If count of loading EQP is more then 2, equipment is released at specific point before consuming all WIP

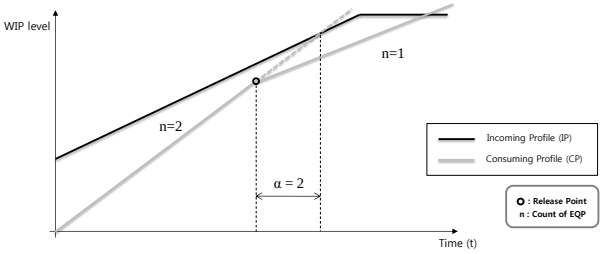

Fig. 5. Release

3.1.3 End If single loading EQP exist, equipment is released at specific point which is consuming all WIP

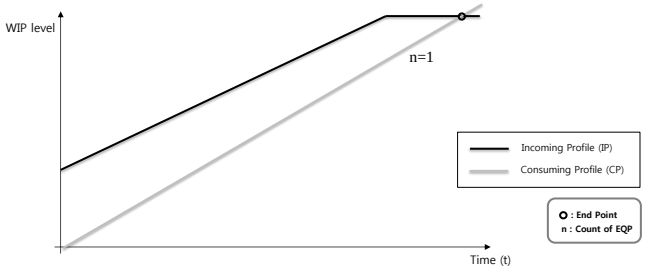

Fig. 6. End

3.2 Algorithm of VI Job Change Planning

VI job change planning algorithm is following. First loading equipment count is checked and then check allocation, release, keeping case. Diamond box is decision node and box node is action node. Action is loading / unloading activity such as allocation, release, end, initial allocation, keeping.

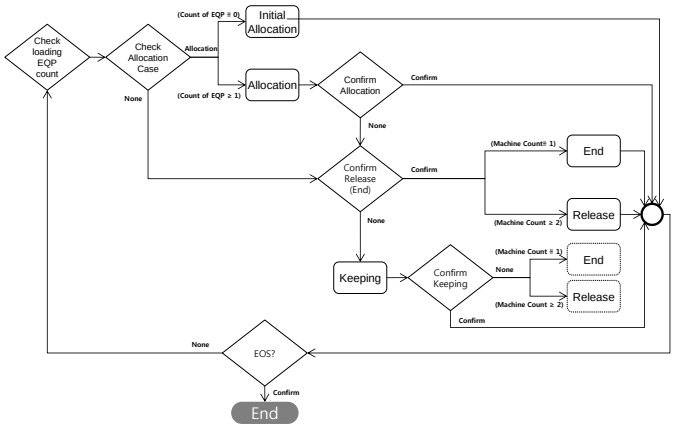

Fig. 7. Algorithm

4 Application: LCD VI Job Change Planning

The GCS is applied to LCD VI job change planning. The plan is planned by a foreman at every shift. Figure x show two Gantt charts which are simulation result

and actual result. The two Gantt charts are similar and shift moving quantity is almost same. Figure x shows the result.

Fig. 8. KPI Viewer

5 Conclusions

For efficient job change planning in LCD industries, basic model and operations of GCS are introduced. Recently, the project with a LCD and tire company which is related to equipment arrangement using GCS is in progress. And it is showed that illustrative application example that is implemented in LCD industry. As GCS has flexible and general data structure, it might be suitable for other industry such as tire industry. But GCS needs to reflect other constraints such as tool capacity, finite WIP capacity.

Job change plan from GCS can be used at shop floor directly. It can be also used as input of short-term scheduling system. Out research team propose 3-layer architecture of simulation-based FAB operation management. GCS is middle part of that 3-layer architecture. In that case, short-term scheduling system has guideline which provides job change plan of bottleneck equipment.

6 References

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