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# Simulation and Optimization in Production Logistics Based on eM-Plant Platform

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**Abstract.** The optimization of production logistics system is an important way to improve enterprise's productivity, cut down cost and improve equipment's utilization. Production logistics system is highly randomized, complicated and discrete system, which can hardly be modeled and analyzed in the traditional way, so computer simulation technology and eM-Plant simulation platform were introduced in the paper to model and analyze production logistics system, more than modeling eM-Plant also can analyze production logistics system's equipment's utilization, working efficiency, production capacity statistics effectively, which can offer useful guideline for production logistics system optimization and scientific decision-making.

**Keywords:** Production logistics; eM-Plant; Simulation; Optimization

## 1 Introduction

Production logistics should feature characteristics such as continuousness, smooth, parallel, proportionality, balance, flexibility, but many enterprises has production logistics problem including low productivity, more WIPs, long production cycle and waste of resources. The computer simulation technology is a effective way to find and solve these problems, the article takes eM-Plant simulation software to set up X4105BC diesel engine's production logistics and optimize simulation models, the simulation and verification can offer great decision making support for the assembly line's production logistics optimization, which ensure the scientific management decisions.

## 2 The Assembly Line's Production Logistics

### 2.1 Process Route

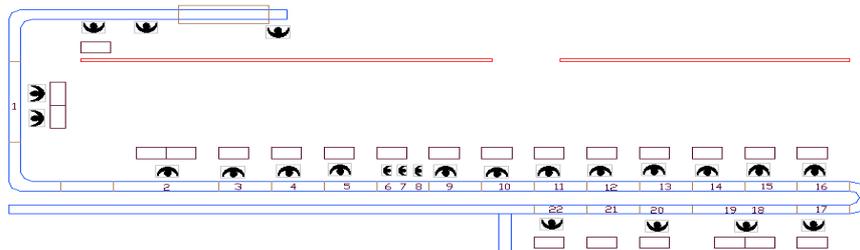
The X4105BC diesel engine is the main product of some manufacturing enterprises, the product mode of X4105BC diesel engine is in a multi-variety, small batch and make-to-order way. The whole Diesel assembly process includes 22 procedures, which is listed in Table.1.

**Table 1.** X4105BC diesel engine assembly route

No	Procedure	No	Procedure	No	Procedure
1	Crankshaft	8	Flywheel	15	Rocker
2	Cylinder	9	Oil Pan	16	Gears Lid
3	Piston and Rod	10	Starter and Generator	17	Nozzle and Cylinder Cover
4	Flywheel Cover	11	Cylinder Lid	18	Exhaust Pipe
5	Oil pipe	12	Water Pump and Pipe	19	Water Manifold
6	Oil Cooler	13	High-Pressure Oil Pump and Air Filter	20	Pulley Wheel
7	Left Side Cover	14	Gears and Intake Manifold	21	Oil Filter

### 2.2 Production Lline Layout

X4105BC diesel engine assembly line was built on a 108m-long non-power roller conveyor belt, the layout of the assembly line shown in Fig.1.



**Fig. 1** The layout of the assembly line

### 3 Production Logistics Simulation Model

#### 3.1. Assembly Line Simulation Bbased on eM-Plant

Based on the X4105BC diesel engine process route and assembly line layout, the simulation model of the Assembly Line X4105BC build in eM-Plant is showed in Fig.2

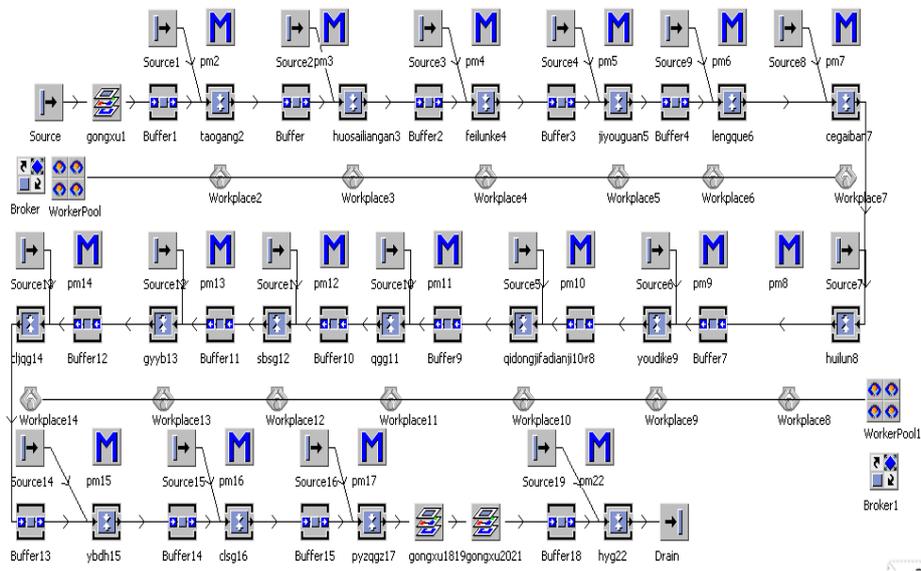


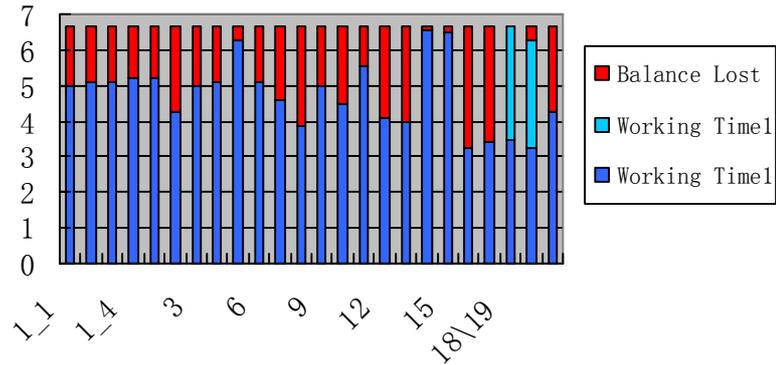
Fig.2. The eM-plant simulation model of X4105BC assembly line

In the simulation model, the assembly buffers are modeled in EM-plant's Buffer component, the Capacity property of the EM-plant's Buffer can specify buffer maximal number parts which can accommodate; the workstations are modeled in EM-plant's ParallelProc component, the set-up and processing time property of the EM-plant's ParallelProc can specify the workstation's setting-up and processing time; EM-plant's WorkerPool component is used to model worker dispatching, EM-plant's Broker component can set worker dispatching rules, witch can route worker from the WorderPool to the right workstations.

#### 3.2. The Simulation Results by eM-Plant

Once the assembly line's simulation model is completed, run the simulation model, eM-plant can offer many kinds of statistics table and chart for us to analyze and

optimize. Here we take the workstation's working balance histogram to analyze the workstation working load, which is show in Fig.3.The blue heap in the workstation's working balance shows one worker's total working time, the red heap in the workstation's working balance mean balance lost of the assembly line. Fig 3. tells us than the there is huge balance loss in the assembly line, which results in waste of resources and time, and the assembly line must be optimized.



**Fig.3.** Assembly Line Balance Histogram

## 4. The Optimization and Simulation of Production Logistics

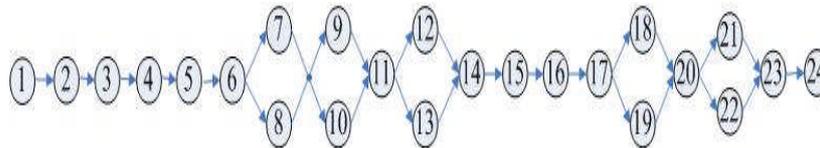
### 4.1. Assembly Line Process Route Optimization

After field investigation based on the eM-plant simulation results, we decomposition working procedures1 and divide it into 5 sub-working procedures, namely working procedures1,2,3,4,5. since working procedures 18,19 and 20,21 are completed by a workers, so we combine working procedures 18,19 and 20,21 into one. The assembly process route after adjustment is shown in Table 2.

**Table 2.** X4105BC diesel engine assembly route after optimization

No	Procedure	No	Procedure	No	Procedure
1	Body Washed by Machine	9	Oil pipe	17	High-Pressure Oil Pump and Air Filter
2	Body Washed by Hand	10	Cylinder Oil Cooler	18	Gears and Intake Manifold
3	Camshaft Cushion	11	Left Side Cover	19	Rocker
4	Camshaft Bush	12	Flywheel	20	Gears Lid Exhaust pipe
5	Camshaft	13	Oil Pan	21	Nozzle and Cylinder Cover
6	Cylinder	14	Starter and Generator	22	Exhaust pipe and Pulley Wheel
7	Piston and Rod	15	Cylinder Lid	23	Pulley Wheel and Oil Filter
8	Flywheel Cover	16	Water Pump and Pipe	24	Return Oil Pipe

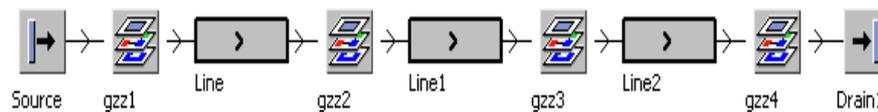
And the assembly sequence after Optimized is shown in Fig.4.



**Fig.4** X4105BC's assembly sequence diagram after optimization

#### 4.2. Simulation Model after Optimization

After adjustment and optimization the assembly route includes 24 working procedures, which are divided into four workstations, each workstation need only one operating workers to complete assembly tasks. The optimized simulation model shown in Figure 5, 6,7,8,9.

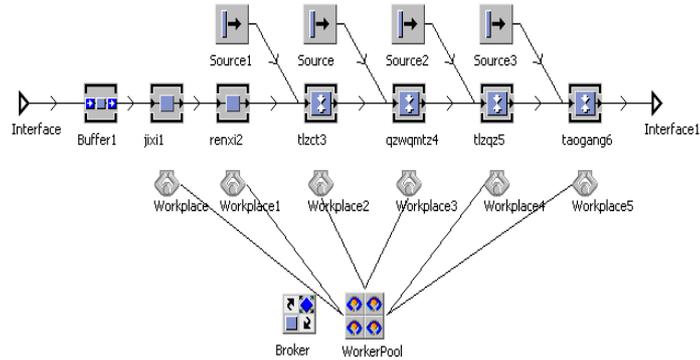


**Fig.5** X4105BC's assembly eM-Plant simulation model after optimization

Here the “Source” means diesel engine supply; “Line” means powered conveyor which transfer diesel engine between workstations, Drain means the completion of the

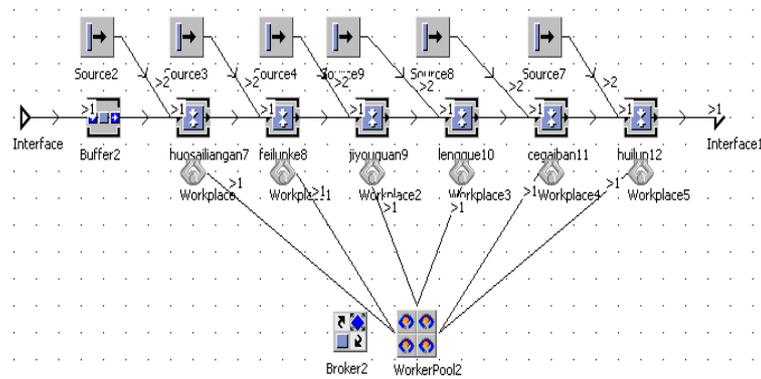
assembly line, gzz1, gzz2, gzz3 and gzz4, means the four workstation after optimization respectively.

workstation 1 include six working procedures, which are first wash, second wash, camshaft bushes, crank wats, crankshaft, cylinder. The Source1, Source2, Source3 mean the required component supply , the eM-plant simulation model of the Workstation 3 shown in Fig.6.



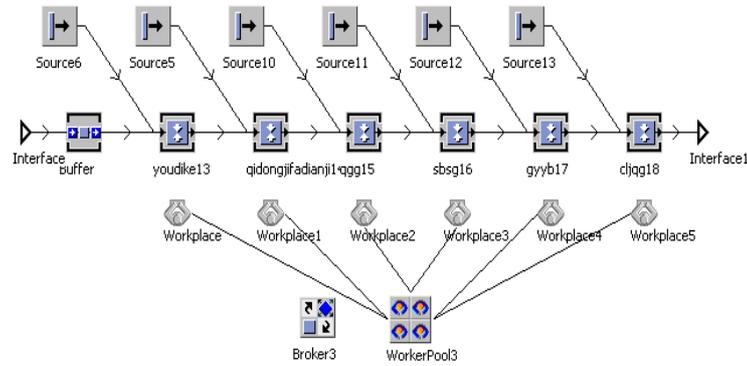
**Fig.6** eM-Plant simulation model of workstation1 after optimization

Workstation2 include six working procedures, which are piston, flywheel, oil pipes, cooler, side cover, flywheel and other six processes, the eM-plant simulation model of the Workstation 3 shown in Fig.7.



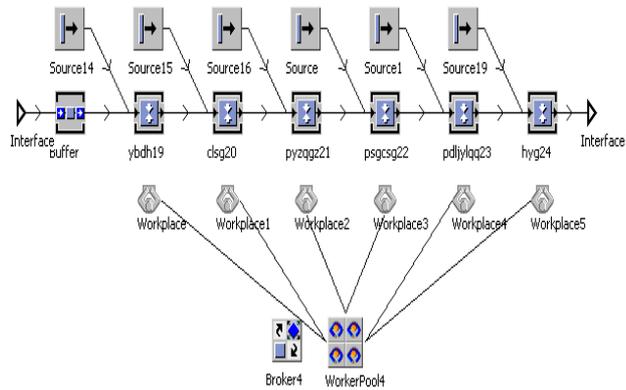
**Fig.7** eM-Plant simulation model of workstation2 after optimization

Workstation3 include six working procedures, which are oil pan, starter motor, cylinder head, water pump, high pressure oil pump diesel filter, how the gear into the trachea, the eM-plant simulation model of the Workstation 3 shown in Fig.8.



**Fig.8** eM-Plant simulation model of workstation3 after optimization

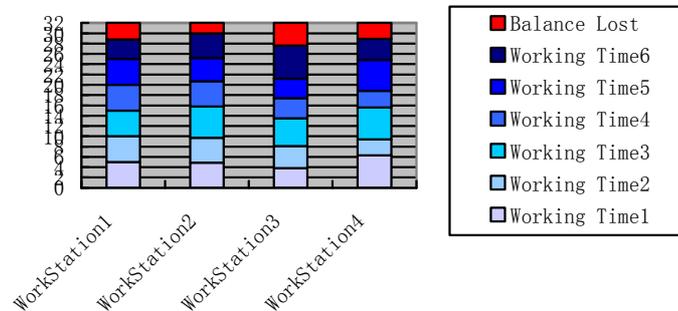
Workstation4 includes six working procedures, which are the arm rings, gear cover, injector cylinder covers, exhaust pipe, pulleys oil filter, oil pipes, the eM-plant simulation model of the Workstation 4 shown in Fig.9.



**Fig.9** eM-Plant simulation model of workstation4 after optimization

### 4.3. Simulation Results After Optimization

Once the optimization simulation model is completed, run the simulation model, we can get the interesting statistics after the simulation, here we take the workstation's working balance as an example. After the optimization, the workstation's working balance histogram is shown in Fig.10. The blue heap in the workstation's working balance histogram means all processing time for each workstations, the red heap means the total balance loss, it is clearly that after optimization, the assembly line's balance lost is improved greatly and the working procedures processing is in a proportional way, which can lead a effective drop-down WIPs.



**Fig.10** Assembly line balance histogram after optimization

After optimization, the number of workers in the assembly line can be cut down largely, and the worker's working efficiency has greatly improved from 65.41% to 96.19% on the average. And also, the WIP's number and occupation rate in each buffer has greatly reduced from 65.834 to 9.024 on the average, which speeds up the enterprise's logistics working efficiency greatly.

## 5. Conclusions

Many enterprise are facing production logistics problem such as WIP controlling, long production cycle ,low working efficiency and devily delay etc, Handling these problem always means production mode adjustment which results in production line shutdown and assembly line re-balance, this may bring enormous loss if not handled carefully and rightly. With professional simulation software such as eM-Plant,we can build production logistics simulation model in a modular, hierarchical way, eM-Plant 's simulation mode and it's statistics, data analysis and optimization capabilities can offer powerful support to for enterprise's decision making.

## Acknowledgements

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