ARGESIM COMPARISONS

An Object-Oriented Solution of ARGESIM Comparison "C2 - Flexible Assembly System" with AnyLogic

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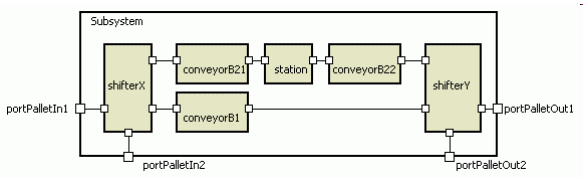
Simulator: AnyLogic (www.xjtek.com) is a general-purpose simulation environment for discrete, continuous and hybrid systems generating cross-platform standalone Java models.

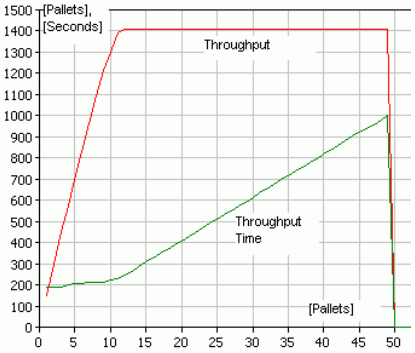
Model: The assembly system consists of 8 subsystems of the following structure:

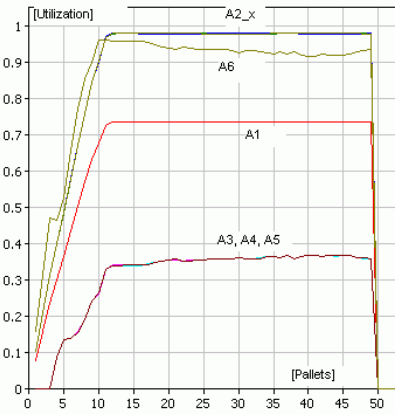


The objects inside the subsystem are representing ShifterX, Station, ShifterY and the intermediate conveyor belts B1, B21 and B22. They are connected via ports to exchange the pallets and some status messages like "Ready" and "Busy".

Task a: Control Strategy/ Statistical Evaluation: Generally the ShifterX of a subsystem checks locally whether the pallet requires processing if the conveyor belt B21 is free. However in subsystem A2_a only every third and in A2_b only every second pallet is shifted. A3 uses additionally a global strategy: A6 must be busy to approve the shift. A4 and A5 perform shifts only if the previous station(s) (A3/A4) had already processed the pallet. This strategy yields in a minimal throughput time also in the case of few pallets.

Statistical data of utilization, and throughput time are collected via Dataset objects - displayed in charts within the AnyLogic environment; this evaluation also can be done via Java statements in the model.





Task b: Simulation Results. Analytical investigations validate the simulation results:

The minimal throughput time is the sum of operation times in the required stations (A1, A2 and A6), therefore 3 up and 3 down shifts (B1-B2), and the travel time for one conveyor B1 loop. Maximal throughput of a station equals simulation time (8 h) divided by the sum of operation time and loading time (1.33 s). A3, A4, A5 and A6 can process about 2269 pallets. Thus the A2 stations, assembling around 1409 pallets, cause the bottleneck.

MinThroughputTime	191.67
MaxThroughputA1	1763.27
MaxThroughputA2	469.57
MaxThroughputA3	1350.00
MaxThroughputA4	1350.00
MaxThroughputA5	1350.00
MaxThroughputA6	919.15
MaxThroughput	1408.70
MaxUtilizationA1	0.73
MaxUtilizationA2	0.97
MaxUtilizationA3	0.93
MaxUtilizationA4	0.93
MaxUtilizationA5	0.93
MaxUtilizationA6	0.95

Hence the maximum utilization of a station is the maximum throughput multiplied by the operation time of the station divided by the simulation time. Graphs and tables show results of summary statistics.

$N_{Pallets}$	Throughput	$t_{Throughput}$
1	150	191.67
3	451	191.67
5	698	206.41
7	964	209.09
9	1214	213.50
11	1394	227.34
12	1409	245.32
13	1409	265.76
20	1409	408.67
40	1409	819.26
49	1409	1003.9
50	0	0

Task c: Simulation Results - Optimisation: Additional Java code sets up a loop from 1 to 50 pallets (optimum 12 pallets):

```
for (n=1; n <= 60; n++) {
  addPallet();
  forerun();      // 2 hours
  collectData(); // 8 hours
}
```

The simulation stopped at 50 pallets due to a deadlock. AnyLogic also offers the OptQuest environment for optimisation (not used here).

C2 Classification: Object- / Process-oriented Modelling

Simulator: AnyLogic V.5