31 Minimizing the Variance of Fulfillment Cycle Time in a Central Fill Pharmacy: Why and How

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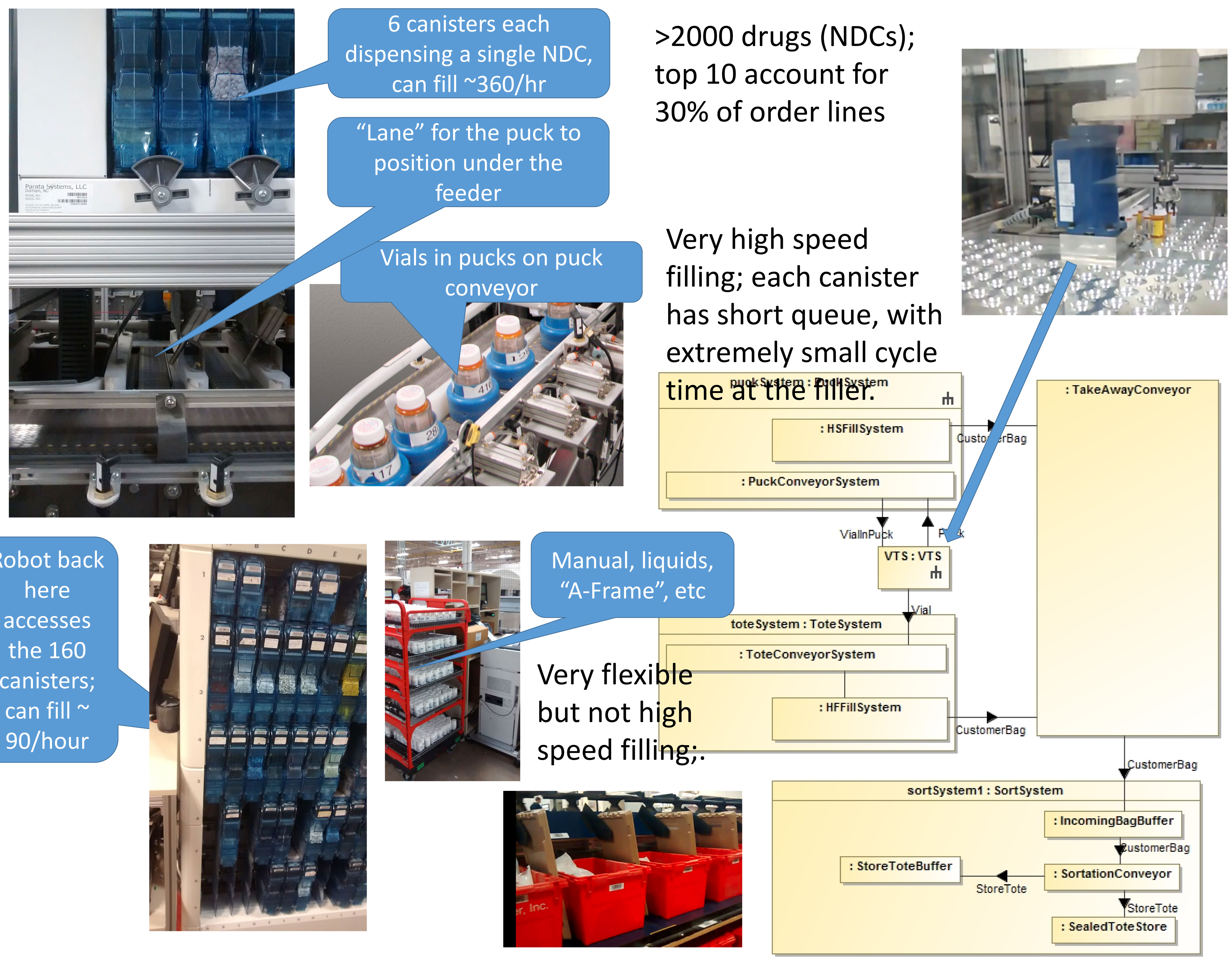
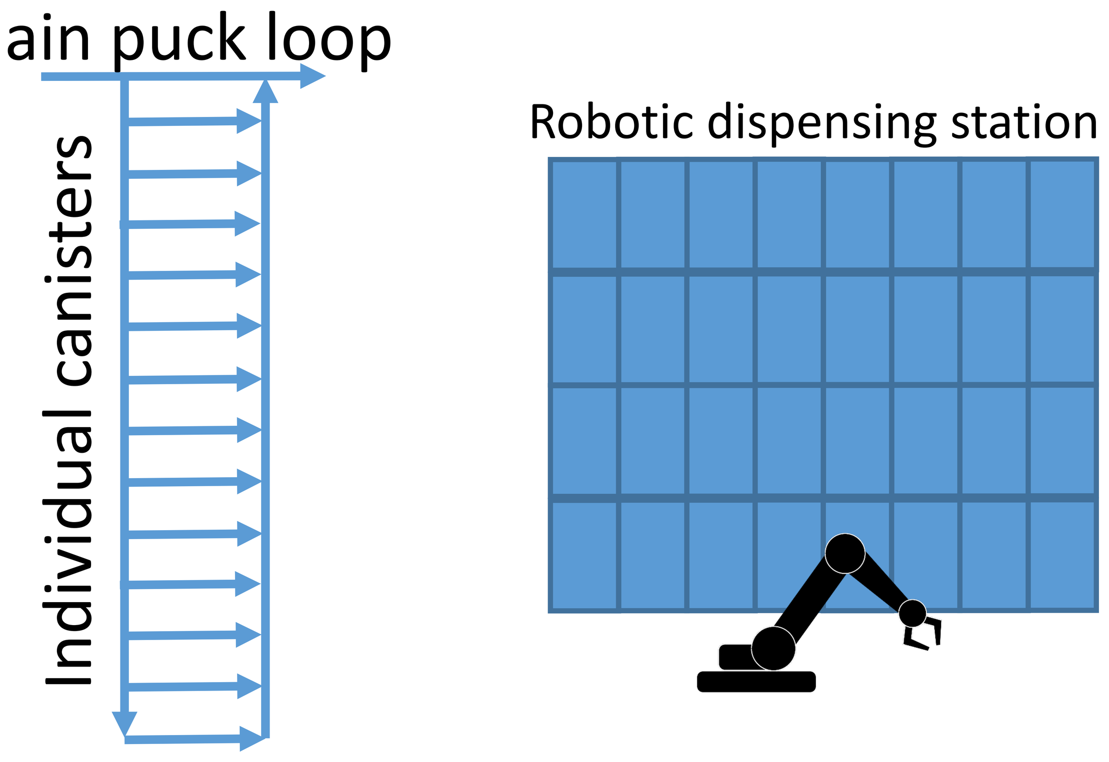


The problem: number of pharmacies served is much larger than the number of lanes in the sortation system, AND, orders arrive continuously through the day. => wave picking

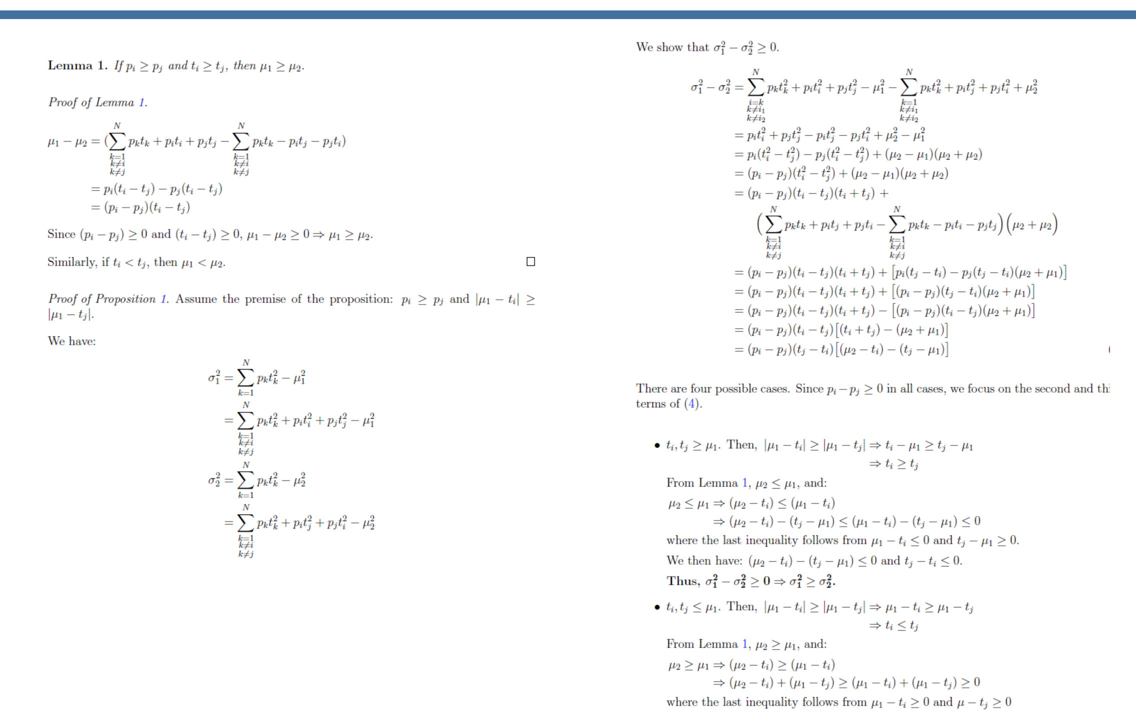
The problem: While there may be distinct boundaries between waves at release, the variability of fulfillment cycle time causes "wave overlap"

The proposal: assign NDC to dispense channel to minimize the *variance* of fulfillment cycle time.



Variable component of fulfillment cycle time is travel time on the high speed filler and robotic arm travel

In an "ideal" system (constant travel time between cells with "adjacent" travel times, we can prove that an "organ pipe arrangement" (OPA) minimizes the variance of travel time. The proof is tedious and boring.



A companion effort has almost completed the development of a simulation testbed where we can evaluate the actual impact of the proposal, in terms of minimizing the "wave overlap".

Can use the OPA even when the time between adjacent cells (in travel time order) is not constant to get a heuristic solution. Can use pairwise interchange, based on specific conditions, to try to improve the solution.

For a chosen λ, we perform 100 experiments for different randomly generated travel times and order rates. For each experiment, we compute the optimal variance V^* and the optimality gap resulting from the heuristic and the organ pipe arrangement. The optimality gap is computed as $\frac{|\hat{V}-V^*|}{V^*}$, where $\hat{V}$ is the cycle time variance resulting from either the heuristic or the OP arrangement. We present the average and standard deviation of the optimal gaps over the 100 runs in table 1.

Table 1: Average and Standard Deviation of Optimality Gaps

	Parameter λ	Inter-travel Time Variance	Organ Pipe	Heuristic
Optimality Gap Average	3.5	0.0816	8.75%	0.65%
	3	0.1111	8.87%	0.38%
	2.5	0.1600	9.24%	0.58%
	2	0.25	8.58%	0.62%
	1.5	0.4444	8.92%	0.89%
	1	1	9.49%	0.80%
	0.5	4	7.22%	0.35%
Optimality Gap SD	3.5	0.0816	0.0755	0.0192
	3	0.1111	0.0884	0.0096
	2.5	0.1600	0.0844	0.0219
	2	0.25	0.0823	0.0244
	1.5	0.4444	0.0950	0.0255
	1	1	0.0903	0.0310
	0.5	4	0.0757	0.0106

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