

A Digital Twin on the Factory Floor: an Eighteen-Month Case Study

E. Eriksen

2022 (synthetic sample)

Synthetic sample paper. Written solely as a sample source for the chi-tragupta documentation's worked examples; the factory, the numbers and the lessons are invented for illustration. Public domain (CC0).

Setting

This case study follows a digital twin of a packaging line – three filling stations, two labellers, one palletiser – through eighteen months of operation at a mid-size synthetic beverage plant. The twin began as a monitoring dashboard and ended as the plant's scheduling authority, and the path between those two points is the subject of this paper.

Phase one: the shadow that earned trust

The first six months deliberately stopped at a digital shadow: sensor data flowed to the model automatically, and nothing flowed back. This was an explicit trust-building decision. Operators could compare the shadow against the line they could see, and its one visible product – a per-station utilisation display – was checked against manual logs weekly. By month four the weekly checks were abandoned as redundant, which we treat as the moment the representation earned operational trust.

Phase two: closing the loop

Actuation began with the lowest-stakes decision on the line: palletiser pattern selection. The twin's predicted changeover cost was allowed to pick the pattern, with a supervisor override that was exercised eleven times in the first month and twice in the sixth. Scheduling authority followed station by station. The deciding argument for each extension was never model accuracy in the abstract; it was the override log, which showed supervisors agreeing with the twin's choice in over ninety-five percent of cases for three consecutive months.

What broke

Two failures are worth recording. A firmware update changed one labeller's event timestamps from local time to UTC, and the twin silently recorded eight hours of impossible sequences before a scheduled report made the corruption visible; input validation on timestamp monotonicity would have caught it in seconds. And a maintenance bypass switch, invisible to the sensor layer, meant the twin scheduled work for a station that was physically disconnected – the one incident that required a human to notice that reality and representation had parted.

Lessons

Trust is built by letting people audit the twin against reality on their own schedule, and it is spent invisibly whenever the twin is confidently wrong. Start with the decision nobody is afraid to delegate, publish the override log, and treat every silent divergence between plant and model as a severity-one defect, because the operators will.