

Demand forecasting in intelligent manufacturing — educational materials and two worked problems

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Improving Demand Forecasting Education
in Turbulent Times
and Beyond at Industrial Environment

prof. Ing. Peter Košťál, PhD.

Ing. Vanessa Prajová, PhD.

Slovak University of Technology

Faculty of Material Science and Technology

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Five years that broke planning

- pandemic halted production and transport
- war and energy crisis reshaped input prices
- supply chain pressure peaked in 2021
- lead times stopped being predictable
- planning horizons shrank from months to weeks



Recent crises have shattered the assumptions behind traditional demand planning.

How a forecast error shows up on the shop floor

- storage full of parts for orders that never came
- one missing item stops the whole line
- expedited transport at several times the cost
- planning meetings without a shared basis
- reviews that cannot say how far off we were



A forecast error manifests physically on the shop floor, not just in a spreadsheet.

The gap is in education, not in tools

- forecasting tools are available and affordable
- systematic education in the field is missing
- the topic sits at the margin of curricula
- planners learn on the job, from their own errors
- the employer pays for those errors



The primary obstacle is a lack of formal education, not a lack of software.

Our domain: intelligent manufacturing

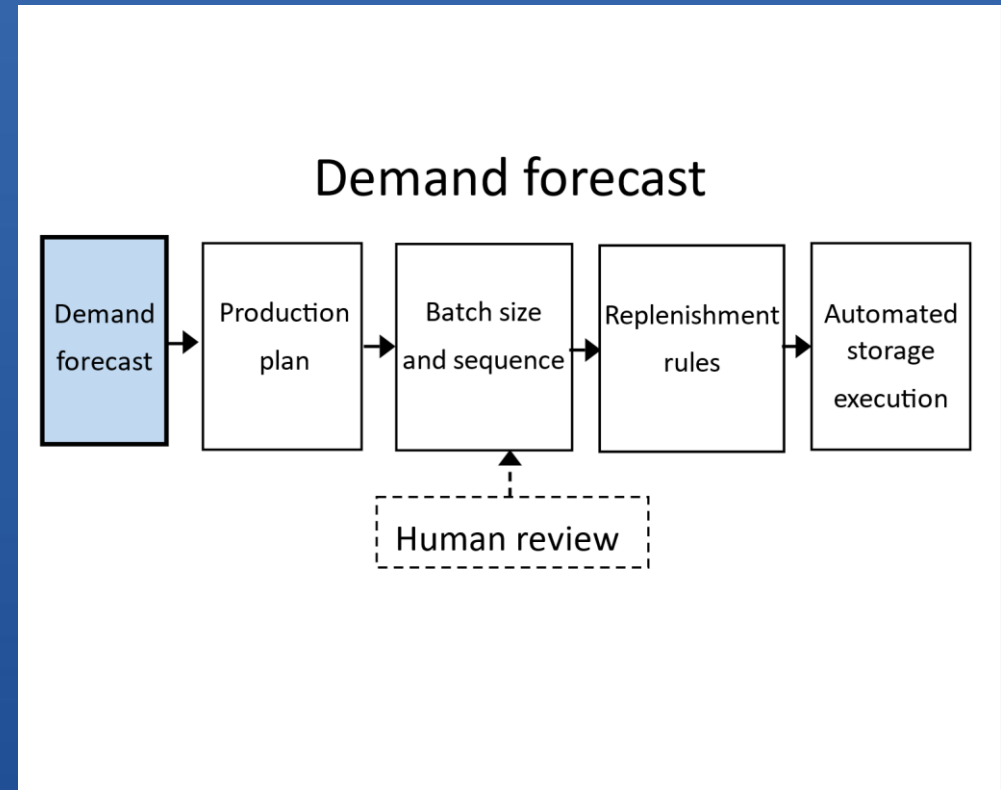
- automated production and storage systems
- material flow driven by a planning system
- decisions taken without a human in the loop
- supply systems as a research focus in Trnava
- forecasting as the input these systems consume



In intelligent manufacturing, the forecast is a direct input to automated decisions.

Where the forecast enters an automated system

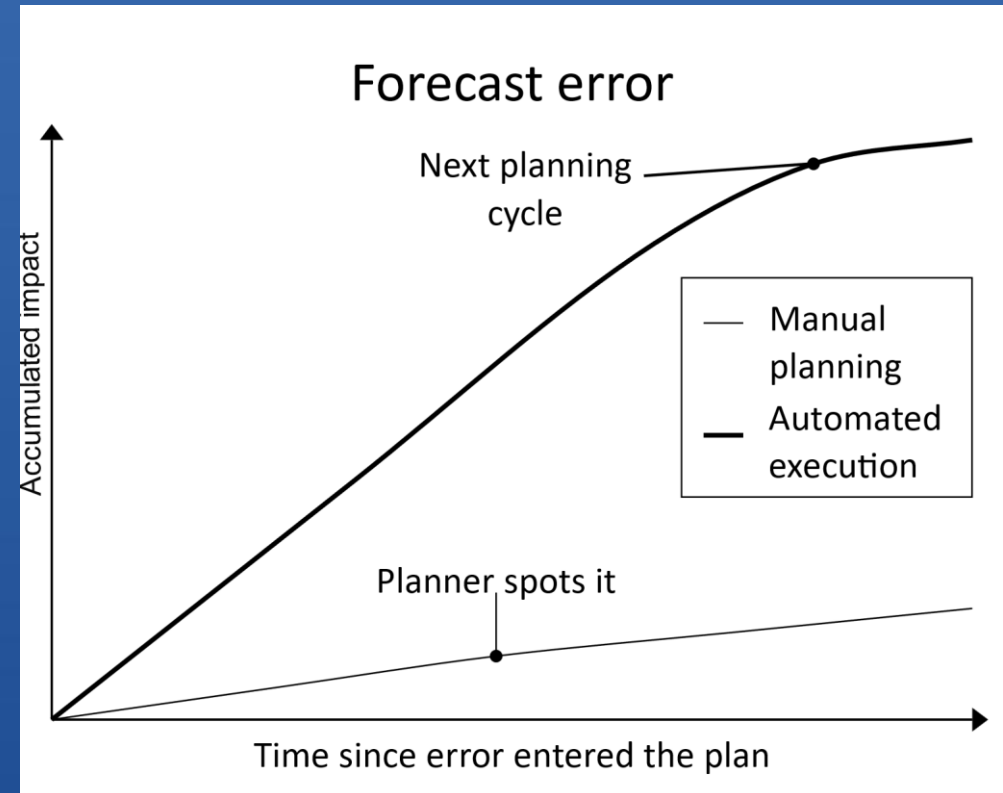
- forecast feeds the production plan
- plan sets batch sizes and sequence
- replenishment rules follow from the plan
- storage system executes without review
- one input, many automated consequences



The forecast is the root cause of automated actions.

Why automation is less forgiving

- a planner notices a wrong number and stops
- an automated system executes it immediately
- the error propagates before anyone sees it
- correction arrives one planning cycle late
- the same error costs more when nobody checks



Automation amplifies the cost of a forecast error by removing the human check.

The economics of accuracy

- forecast error drives safety stock
- service level drives tied-up capital
- the last percentage points cost the most
- the bullwhip effect amplifies upstream
- where improvement actually pays off

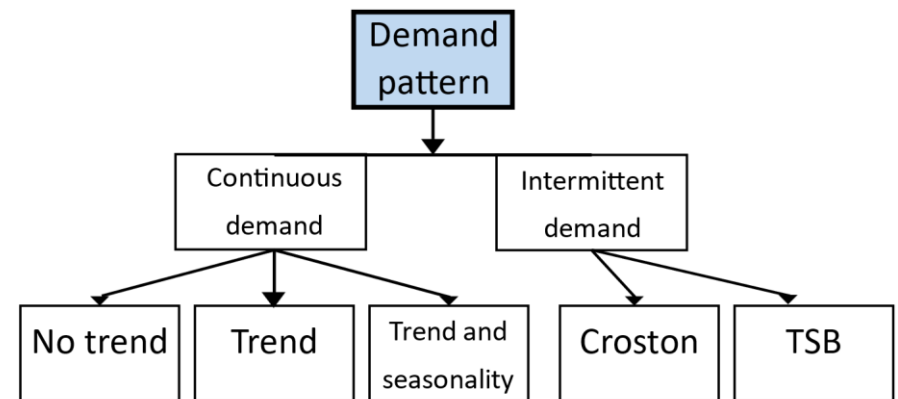


The cost of service level rises nonlinearly, making high accuracy disproportionately expensive.

Choosing a method, not memorising a list

- check the series before picking a method
- trend and seasonality change the choice
- intermittent demand needs its own family
- causal and Box-Jenkins models
- machine learning as one option among many

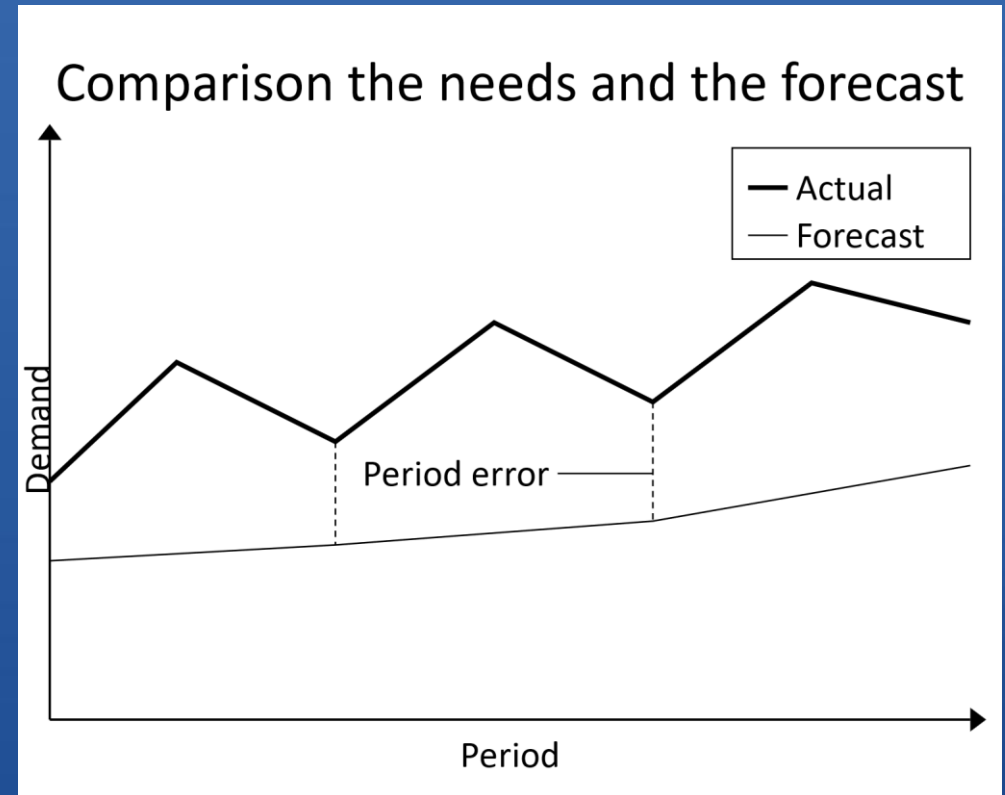
Forecast method choosing



The right forecasting method depends on the data pattern, not on software popularity.

Measuring the forecast error

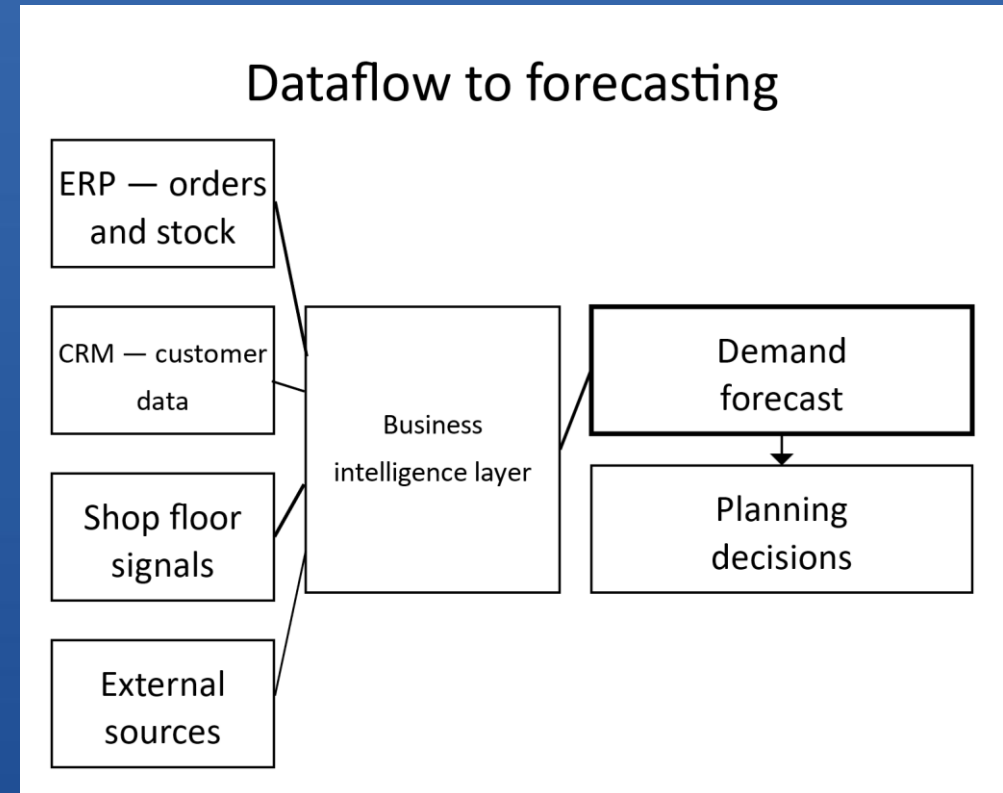
- error of a single period
- magnitude — MAD, MAPE and RMSE
- direction — mean forecast error and signal
- systematic bias is worse than noise
- one number is never enough



No single metric captures forecast quality, use both magnitude and bias.

Where the data comes from

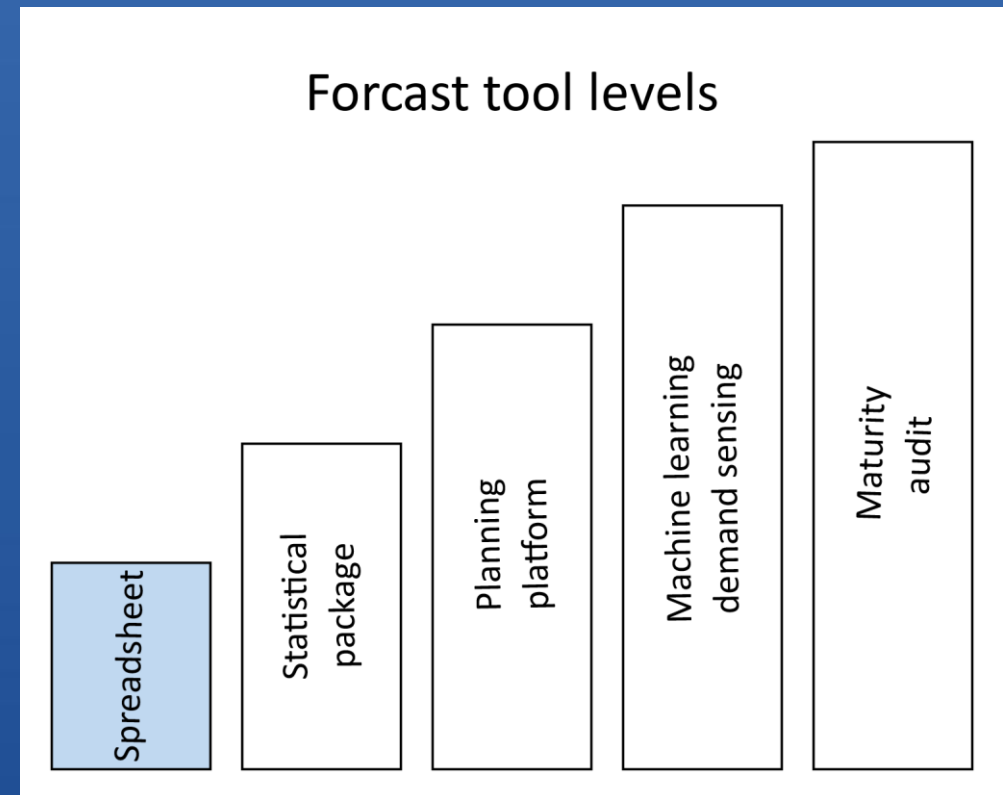
- ERP, CRM and business intelligence layers
- planning horizons of each data source
- shop floor signals in near real time
- customer data as an early demand signal
- explaining why the forecast changed



A forecast is only as good as the data that feeds it.

Software, machine learning and the maturity audit

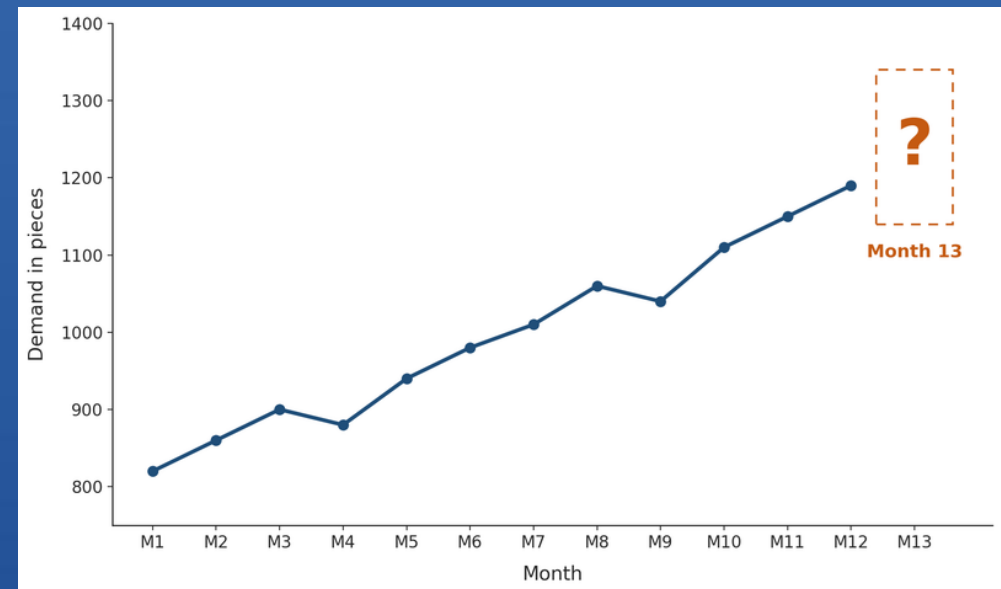
- spreadsheets and where they stop working
- statistical packages and planning platforms
- machine learning applied to forecasting
- demand sensing on near real time data
- auditing the maturity of the process



The audit is the most actionable output, as it identifies the weakest link.

Task 1 • Problem — forecast the next month

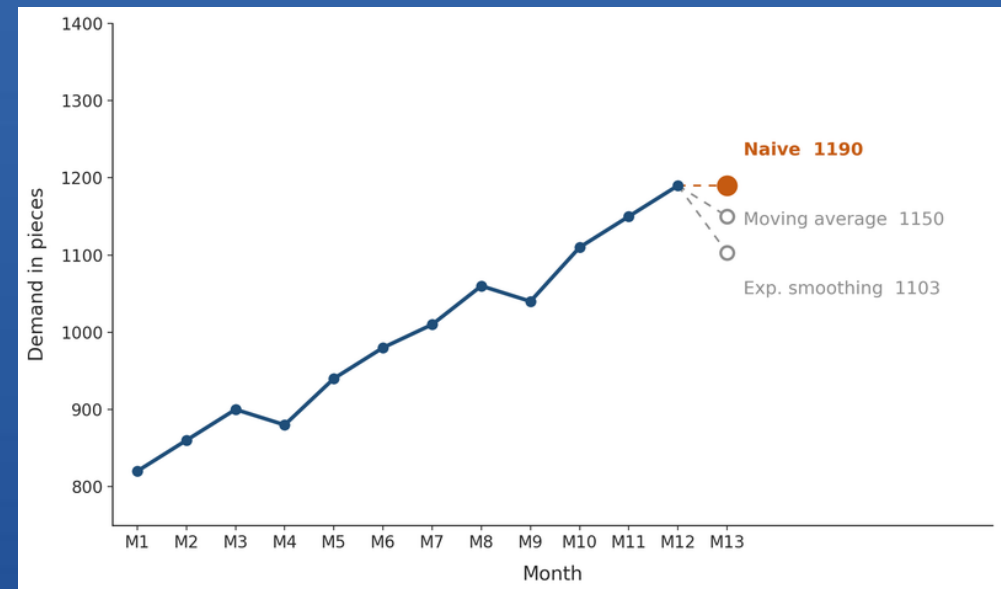
- twelve months of demand for one component
- the series grows steadily across the year
- what will the thirteenth month bring
- what data is available
- what the data does not tell us



Forecasting the thirteenth month is a simple problem with a clear lesson.

Task 1 · Solution — three methods side by side

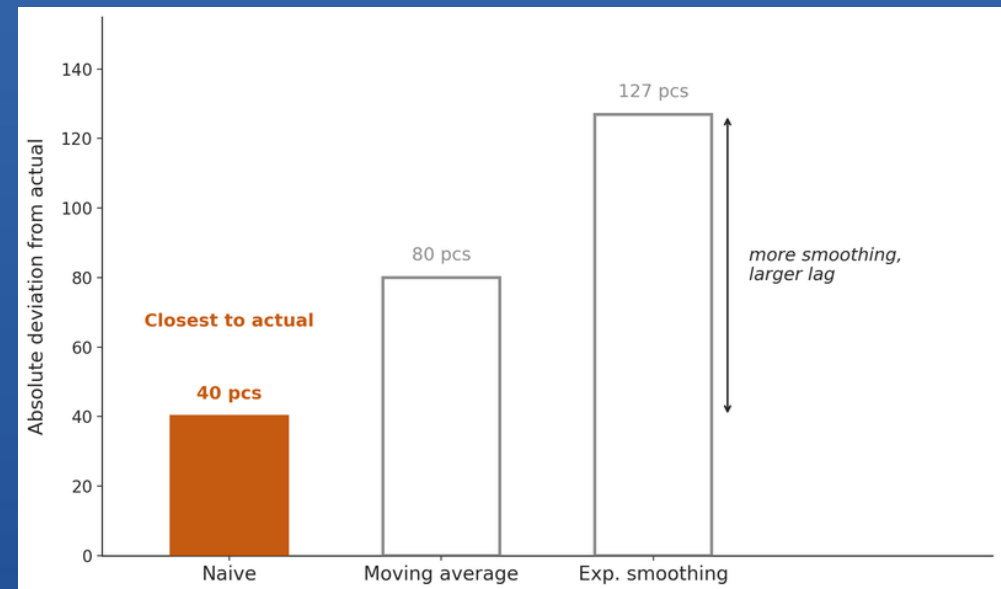
- naive method takes the last value
- moving average over three periods
- simple exponential smoothing
- how the three calculations differ
- why they give different answers



Different assumptions about the past lead to different predictions for the future.

Task 1 · Result — smoothing hurts under a trend

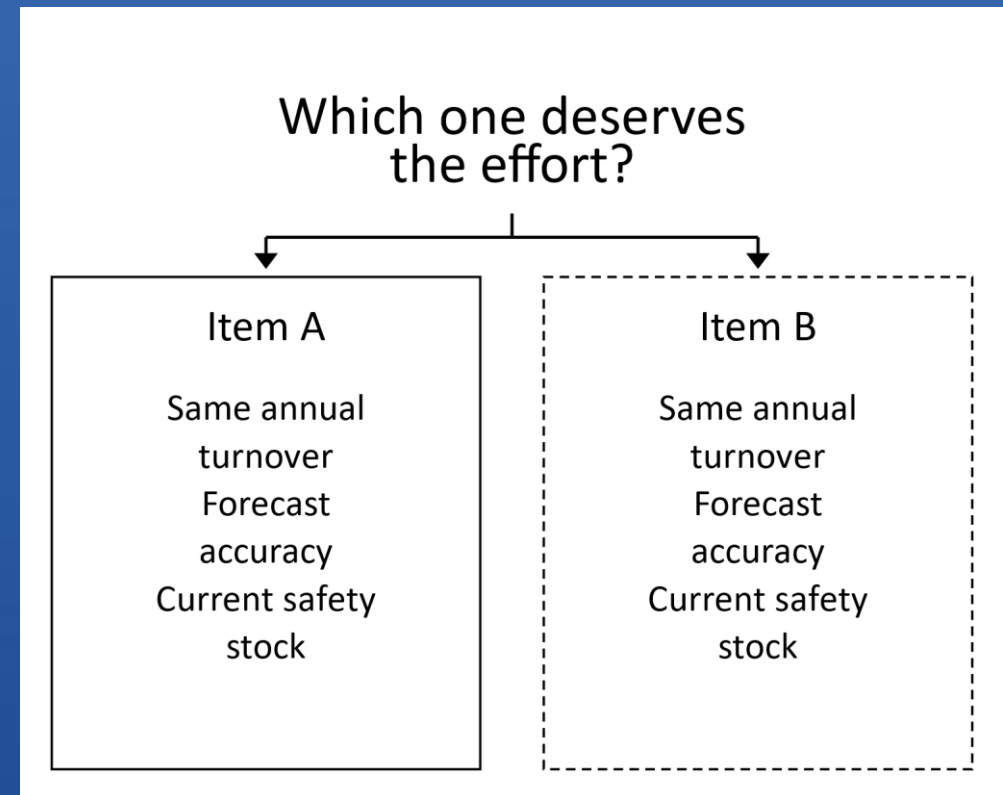
- the actual value of the thirteenth month
- all three methods came out too low
- the more a method smooths, the worse it did
- the simplest method won this round
- a trend needs a method that models it



A trend requires a trend model, smoothing alone creates a systematic lag.

Task 2 • Problem — which item deserves the effort

- two items with the same annual turnover
- one forecast well, the other poorly
- limited time to improve the process
- which one should we work on
- what intuition says

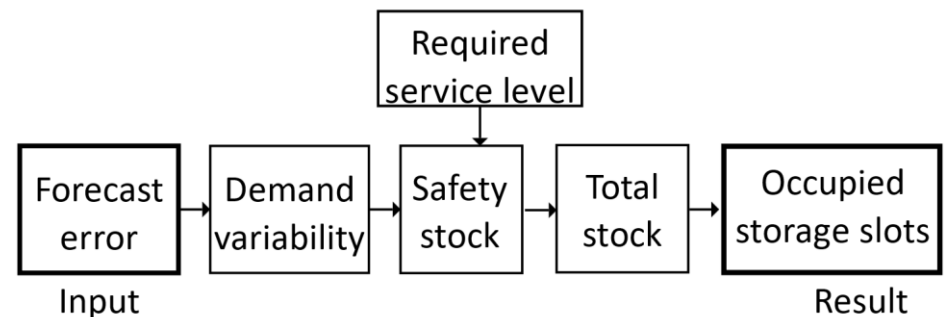


The item with the worst forecast accuracy offers the largest improvement opportunity.

Task 2 · Solution — from error to storage slots

- forecast error sets the safety stock
- required service level fixes the factor
- safety stock converts into storage slots
- slots are a scarce resource in automation
- the same calculation for both items

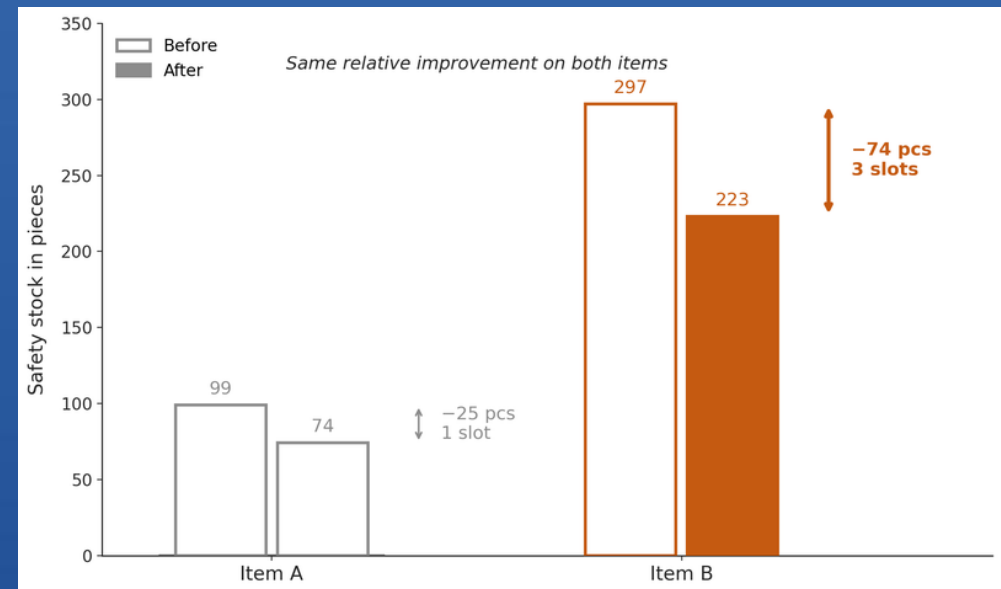
Forecast error to occupied storage slots



The chain from forecast error to storage slots makes the cost tangible.

Task 2 · Result — three times the effect

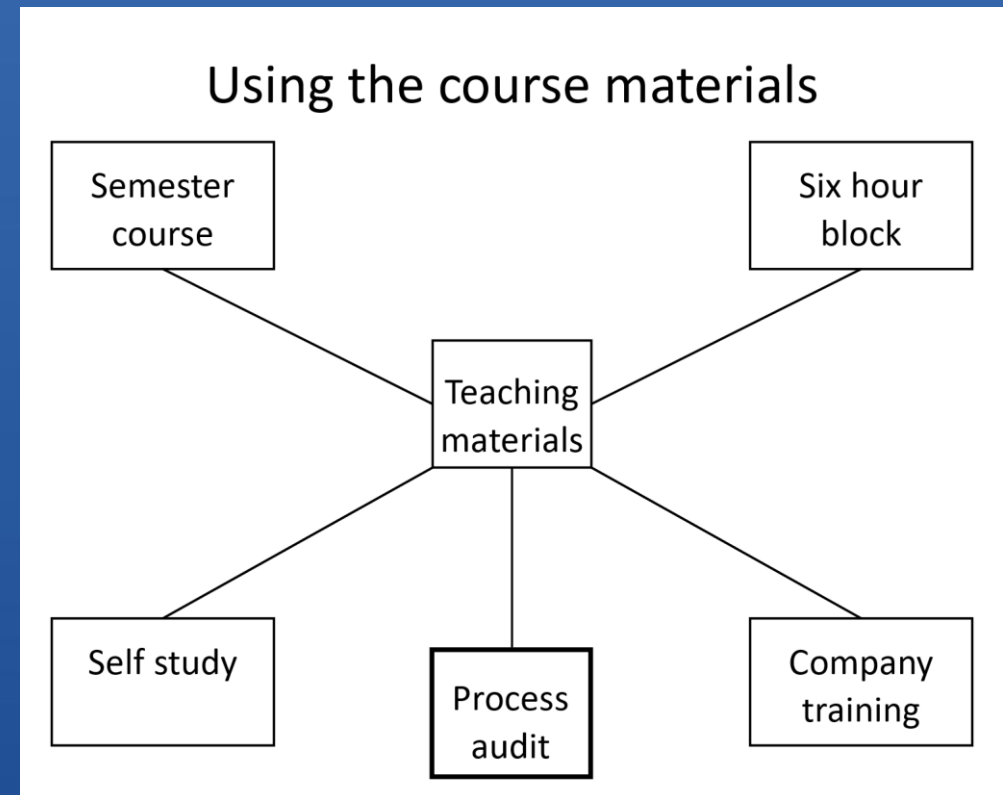
- the same relative improvement on both items
- the poorly forecast item frees far more
- three slots against one
- effort follows the size of the error
- do not invest where it already works



Focus improvement efforts on the highest-error items for maximum return.

Using the materials

- a full semester course or a six hour block
- modular company training on demand
- self study with appendices and references
- the audit questionnaire can be used alone
- open to non partner institutions



The materials are modular and available for diverse educational and industrial uses.

Thank you for your attention

Contact:

peter.kostal@stuba.sk

vanessa.prajova@stuba.sk