White Paper

CMII-810C

Exponential Curve for Intervention Resources and Derivation

Prepared by

CMII Research Institute

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Purpose of This White Paper

The subject curve provides a correlation of varying levels of data integrity with employee effectiveness. This relationship is shown to become exponential when data sets are used in-series. This paper describes the research and data from which this curve was derived.

OUTLINE

- **Curve Based on Eight Data Sets Used In-Series**
- **Source of the Supporting Data for this Curve**
- **ERP Netting Process and Indenture Levels**
- **Weekly ERP Runs and Data Integrity Issues**
- **Test Routine for Validating each ERP Run**
- **Reasons for Greater Instability at Lower Levels**
- **Data Integrity: How Good Is Good Enough?**
- **Conclusions and Recommendations**

Curve Based on Eight Data Sets Used In-Series

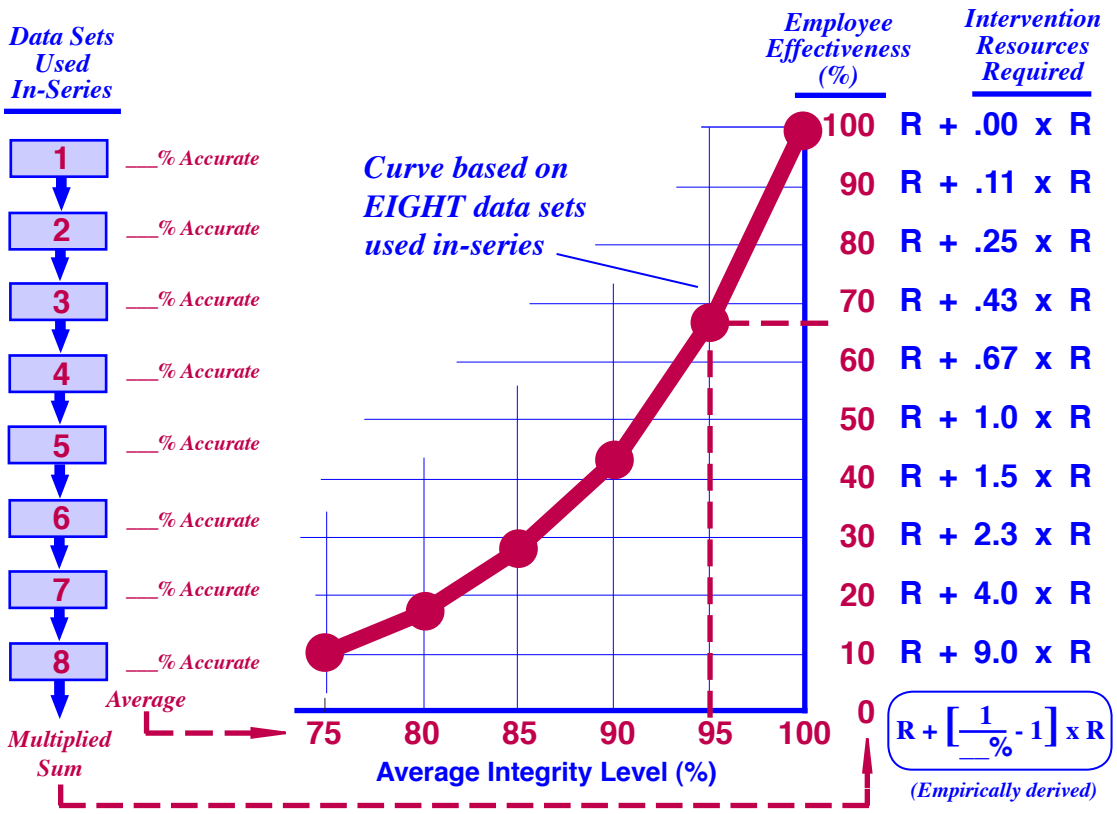
The graph shown below represents a correlation between varying levels of data integrity and employee effectiveness. This specific curve is based on eight data sets used in-series.

To understand the curve, assume all eight data sets are 100% accurate. The sum of 1.00 x 1.00 seven times is 1.00. Plug 1.00 into the formula. It will require R plus "0" additional resources to do the work.

Now assume each data set is 95% accurate. The sum of .95 x .95 seven times is about 0.663. Plug 0.663 into the formula. (1/0.663 - 1.0 = 0.508) It will require R plus an additional 0.508 x R resources to do the same work.

The number of data sets used in-series is often greater than eight. As the number increases, the curve becomes more exponential.

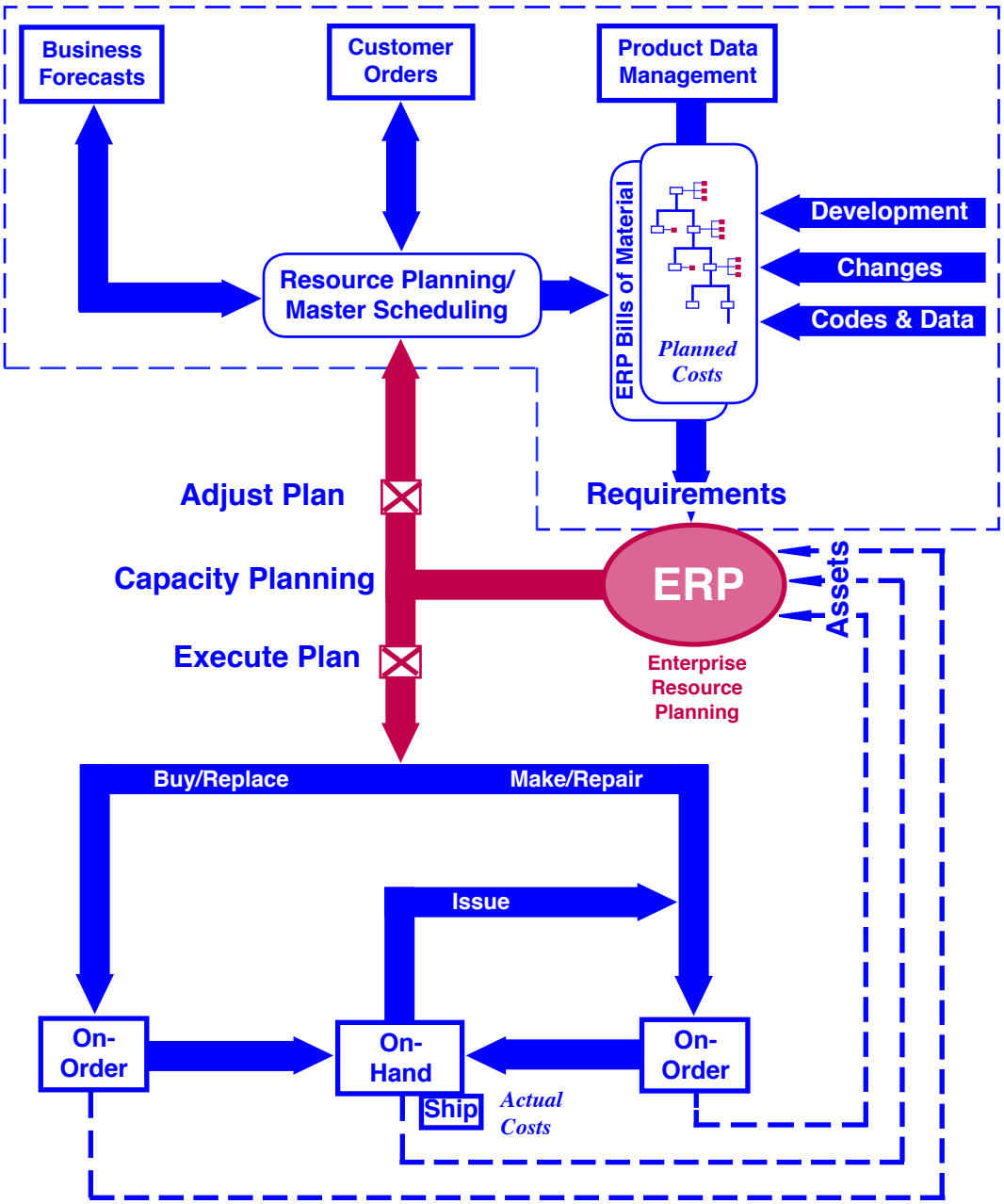
Exponential Impact of Data Sets Used In-Series



Source of the Supporting Data for this Curve

This exponential curve was derived during the 1970s from Manufacturing Resource Planning (MRPII) systems and data derived from their process of "netting requirements versus assets."

Such automated scheduling tools, now called Enterprise Resource Planning (ERP) systems, are used to net material requirements against on-hand and on-order assets, as shown below.

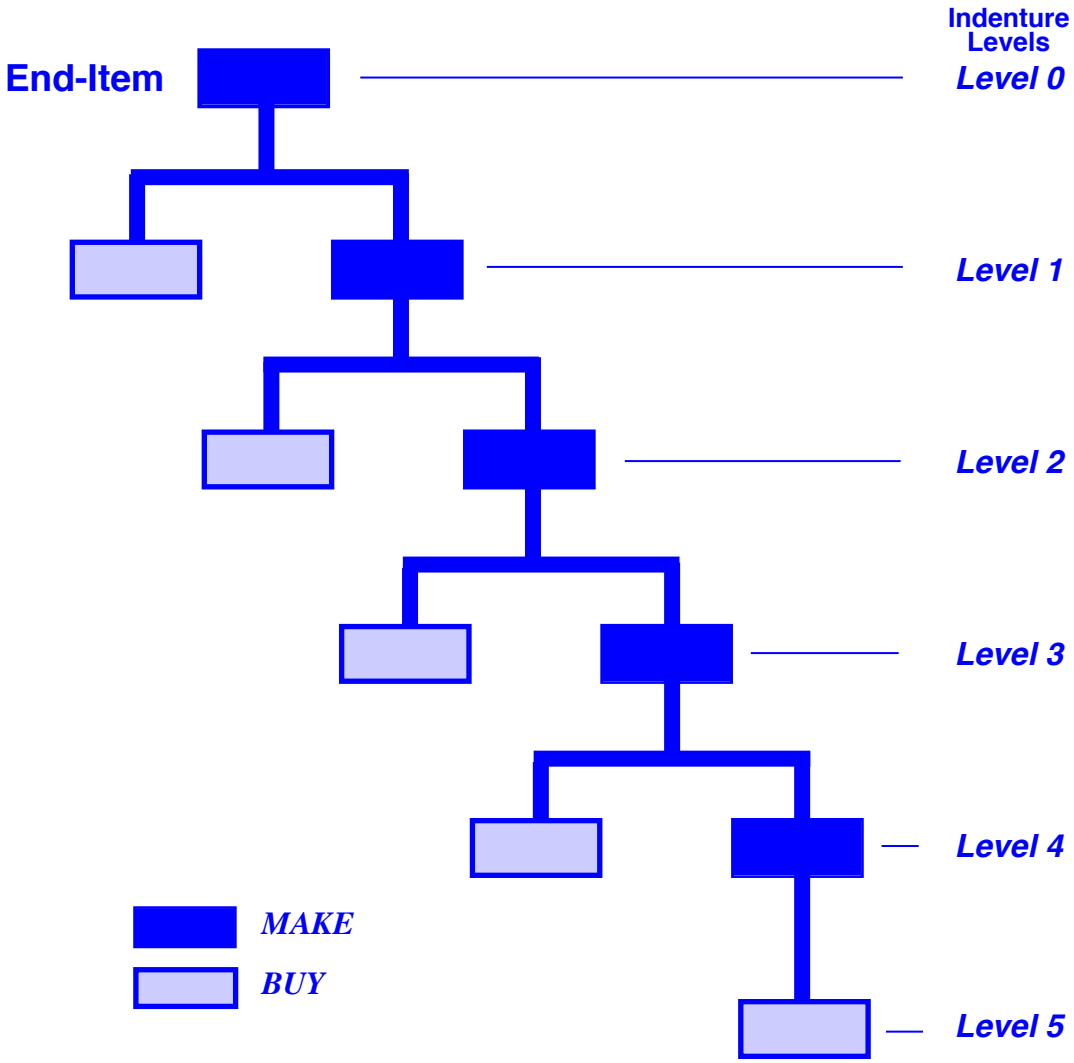


ERP Netting Process and Indenture Levels

The ERP netting process begins with the end-item build schedule and nets the required quantity of end-items in each time period (usually in weekly periods) against on-hand and on-order assets.

The uncovered requirements in each time period are then extended down to the next indenture level and the netting process is repeated. Lead-time setbacks are included in the ERP netting calculations.

The end result of the netting process is a spreadsheet of requirements for each item at each level in the hierarchy. The period-by-period requirements for each item are displayed and rescheduling recommendations are provided to keep requirements and assets synchronized.



Weekly ERP Runs and Data Integrity Issues

ERP runs, at that time, typically occurred on a weekly basis. The IT department would do a "batch run" and then deliver the huge volume of spread sheets to the material scheduling personnel. Spread sheets for MAKE items were separated from spread sheets for BUY items. Each MAKE or BUY part number had its own spread sheet.

The weekly ERP runs were plagued with errors. The manager of the scheduling department would do a quick review of certain spread sheets to determine if the ERP run appeared to be valid. If it appeared to be valid, material schedulers proceeded to order and reschedule their assigned part numbers accordingly. If not valid, the IT department would do another overnight batch run and it would normally be available the next day.

Test Routine for Validating Each ERP Run

The manager of Material Scheduling had a quick routine for determining if a batch run was valid. The spread sheet of requirements for a few part numbers residing at various indenture levels were compared to the previous spread sheets for the same items. If the variation was not excessive, the batch run was concluded to be valid.

ERP Spread Sheets for Item 12345 (Q = quantity)

ERP RUN	NETTED REQUIREMENTS BY WEEK									
	212	213	214	215	216	217	218	219	220	221
Week 212	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Week 213		Q	Q	Q	Q	Q	Q	Q	Q	Q
Week 214			Q	Q	Q	Q	Q	Q	Q	Q
Week 215				Q	Q	Q	Q	Q	Q	Q
Week 216					Q	Q	Q	Q	Q	Q

DISCOVERY: These plots revealed that items residing at the lower indenture levels experience much greater instability than items residing at the higher levels. The increased instability was not linear.

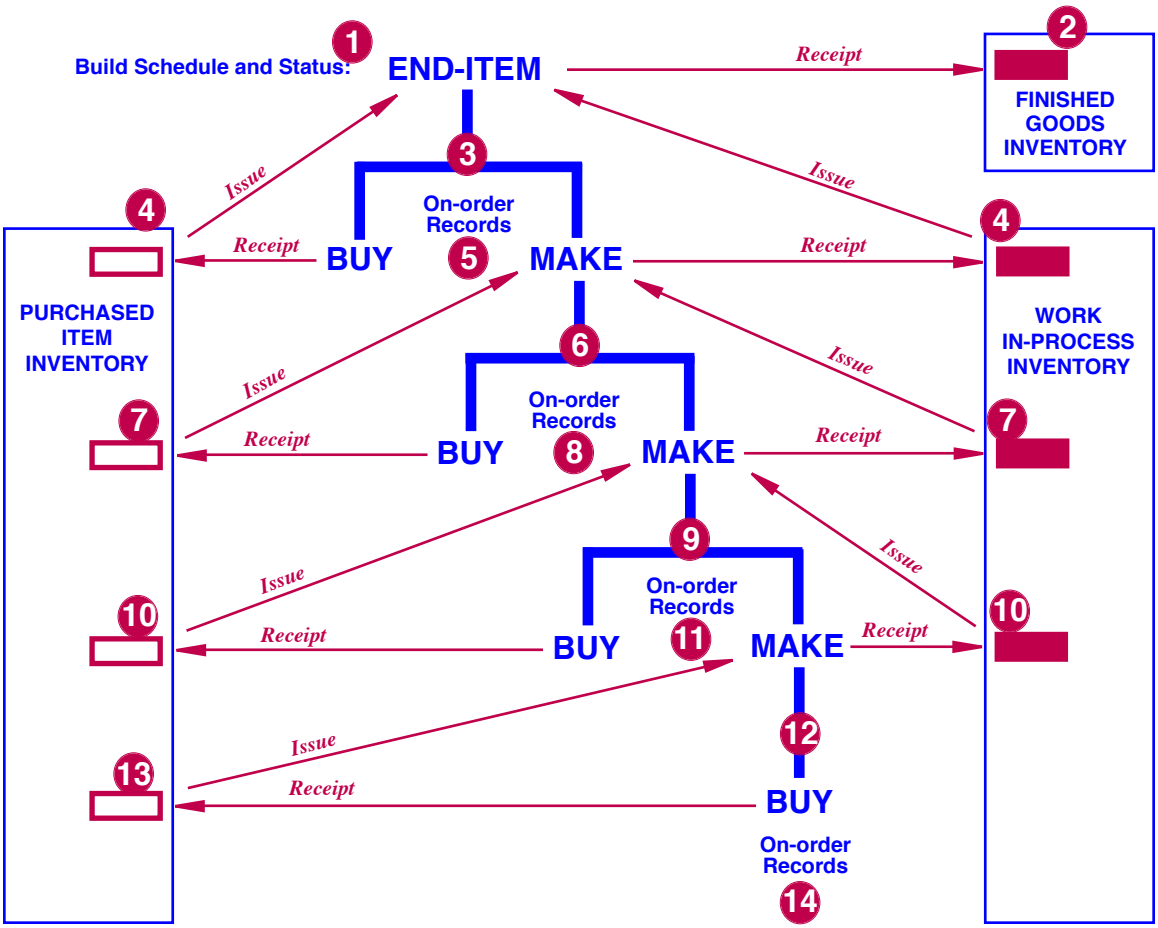
Reasons for Greater Instability at Lower Levels

An analysis was made to determine why instability of the netted requirements increases significantly at each descending level. The root causes became clear.

As the netting process moves down to the next level, errors are carried forward and ERP reads three additional data sets; (1) bills of material, (2) inventory records and (3) on-order material records. The growing instability at each lower level was found to be more or less consistent with the number of data sets added at each level.

ERP-generated spread sheets for items residing at the lower levels were so inaccurate that most items were stocked on a min-max basis. Spread sheets were not generated for min-max coded items.

ERP Data Sets Used In-Series



Data Integrity: How Good Is Good Enough?

Data integrity, per the following illustration, becomes increasingly important as the number of data sets used in-series increases. The use of data sets in-series cannot be avoided. The only option is to maintain a high level of data integrity.

DATA SETS AND NETTING PROCESS →											
Level of Accuracy	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
99.0	99.0	98.0	97.0	96.0	95.1	94.1	93.2	92.3	91.4	90.4	89.5
98.0	98.0	96.0	94.1	92.2	90.4	88.6	86.8	85.1	83.4	81.7	80.1
97.0	97.0	94.1	91.3	88.5	85.9	83.3	80.8	78.4	76.0	73.7	71.5
96.0	96.0	92.2	88.5	84.9	81.5	78.3	75.1	72.1	69.2	66.5	63.8
95.0	95.0	90.2	85.7	81.5	77.4	73.5	69.8	66.3	63.0	59.9	56.9
94.0	94.0	88.4	83.1	78.1	73.4	69.0	64.8	61.0	57.3	53.9	50.6
93.0	93.0	86.5	80.4	74.8	69.6	64.7	60.2	56.0	52.0	48.4	45.0
92.0	92.0	84.6	77.9	71.6	65.9	60.6	55.8	51.3	47.2	43.4	40.0
91.0	91.0	82.8	75.4	68.6	62.4	56.8	51.7	47.0	42.8	38.9	35.4

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Conclusions and Recommendations

The curve on page 2 that correlates data integrity with employee effectiveness, and the formula used to quantify the resources required to accomplish the same amount of work, are both concluded to be valid.

Although this study was originally completed in the 1970s and involved an early version of ERP, the conclusions are more valid today as weekly batches transition to daily uploads.

Automation, in itself, does not make data accurate. Automation may even increase the number of data sets used in-series.

The use of data sets in-series cannot be avoided. The only solution is data integrity. Data integrity deserves top priority.