What is Learning Curve?

When a task is performed repetitively, we "learn" and improve our speed and efficiency the more we repeat the task

- Production time decreases by a fixed percentage each time the QTY produced is doubled – by a exponential amount!
- First documented in aircraft manufacturing ~1940s
- At first, learning was attributed to increased motor skills in the workers as they repeated their tasks
- Later it was realized that management also could contribute to learning with better tools and processes

Common Examples

1= 100 hrs
2= 90 hrs each
4= 81 hrs each

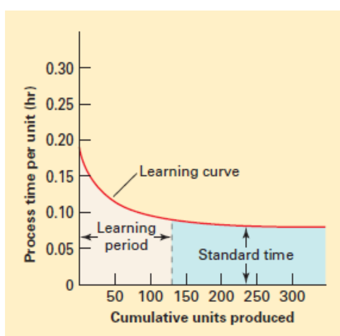
- Bid Preparation: In a large job, how much time(labor) will it take to make all of the pieces?
- Financial Planning: Direct Labor costs will be higher early in a job than later
- Labor Requirements: To produce the required number of units per day will require fewer people the longer we make the item
- Home Building – If all houses in a development are built the same way – at the same time - the builder gets big benefits in reduced construction time.
- Management or production process improvements

The Chart

- Relationship between time to produce a unit vs the number of units produced

Using a Log chart – the "curve " is a straight line. Handy for extrapolation or regression analysis

An industry might use LC to find a "standard time"



Basic Relationship Formula

This formula is the basis of both models

$$y = ax^b$$

b is called the natural slope—it represents the rate of learning [always a negative number

The two models differ in their interpretation of *y* (next chart)

a always represents the theoretical labor hours required to build the first unit produced (a positive number)

x always represents the number (count) of an item in the production sequence (unit #1, #2, #3, etc.)

General Guidelines

- Fit learning curves to historical data when available
  - This is usually the best source, but not always indicative of the future
- Guidelines for use when historical data are not available:
  - Operations that are fully automated tend to have slopes of 100%, or a value very close to that (no learning can happen).
  - Operations that are entirely manual tend to have slopes in the vicinity of 70% (maximum learning can happen). (cont.)

Practical Application

Typical values for repetitive operations in manufacturing. *Not valid if operations are sporadic, as in a job shop*

Electronics	90-95
Machining	90-95
Electrical	75-85
Welding	88-92

- If an operation is 75% manual and 25% automated, slopes in the vicinity of 80% are common
- If 50% manual and 50% automated, expect about 85%
- If 25% manual and 75% automated, expect about 90%
- The average slope for the aircraft industry is about 85%. But there are departments in a typical aircraft factory that may depart substantially from that value
- Shipbuilding slopes tend to run between 80 and 85%

Issues / Impacts

- LC can be interrupted by down-time
- LC can be impacted by changes in production process or personnel
- LC is affected by changes in the SOW
- Curve could change or just jog up (add time)
- Process could be automated
- Customizing a product could change "standard time" **BUT** the customization process could have it's own LC

Discussion

- Commonly used in Manufacturing, financial management and cost estimating
- How could LC affect the price of products I buy?
- Which contracts would most likely benefit?
- Who else in my company or professional network is likely to use LC analysis?
- Which of my suppliers might use LC analysis?
- How can I change my procurement to benefit from LC
- Can an organization exhibit the effects of LC?