

HONORING THE PAST AND  
ADVANCING THE FUTURE  
THROUGH ACCOUNTING  
*A Historical Perspective on the Role of  
Accounting in Mass-Assembly Line  
Production*

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# Agenda

- Introduction / Observations
- Planning & Budgeting
- Tracking Costs
- Control
- ARSENAL OF DEMOCRACY: A Case Study in Mass-Assembly Line Production
- Lessons Learned
- Closing Thoughts / References
- About the Speaker

# Introduction & Observations

- Historic cost perspective of Accounting is the basis for objective, verifiable data for reporting and measuring a firm's economic performance and financial condition.
- Understanding financial history enables decision makers to advance the future by applying immutable Accounting principles for new technologies and businesses.
- Finance is the language of business with Accounting as the vocabulary!

# Planning & Budgeting

- The master budget is made of detailed budgets, but the key driver is the expected demand for a company's products or services.
- Every company must create a forecast of expected demand that translates into a sales forecast.
- Typically, sales revenue = units x average selling price.

## Planning & Budgeting - cont

- As a practical matter, unit growth drives sales, but mix will have a significant impact depending upon its selling price.
- Total revenue and profit realizations will be influenced by which mix (high, medium or low selling price) is more dominant in any given period.

# Planning & Budgeting - cont

Once a sales forecast is prepared, other budgets are prepared to support that level of expected activity. The sequence would be:

## **Sales/Revenue Forecast (Master Budget)**

- **Purchases/Production Budget**
- **Cost of Goods Sold Budget**
- **Operating Expense Budget**
- **Income Statement Budget**
- **Cash Budget**
- **Balance Sheet Budget**

# Tracking Costs (Absorption Costing)

- Variable + fixed costs are included in product costs.
- Therefore unit costs will be in direct proportion to physical output.
- Higher physical output lowers unit costs because total costs [variable + fixed] are spread over a larger number of units and vice versa.

## Absorption Costing - example

If fixed costs are \$4000 per day, and the firm makes and sells 200 units per day, then the daily fixed cost per unit =  $\$4000/200 = \$20$ . If the firm doubles its output to 400 units, accordingly, its fixed cost per unit falls to \$10 as  $\$4000/400 = \$10$ . If daily total costs are \$4500 [\$4000 fixed and \$500 variable] and the daily physical output = 200, the total cost per unit equals  $\$4500/200 = \$22.50$ . If daily total costs are \$5000 [\$4000 fixed and \$1000 variable] and the daily physical output = 400, the total cost per unit now equals  $\$5000/400 = \$12.50$



# Tracking Costs

## (Activity Based Costing or ABC)

- Identifying the activity, known as “cost driver” that causes incurrence of a cost.
- Activities that contribute to fixed costs could include: rent, insurance, production order preparation, clean-up & set-up, quality inspection.
- Activities that contribute to variable costs could include placement of orders, raw material acquisition, material handling, and quality inspection, clean-up & waste disposal.
- Determine the frequency rate of each activity and multiply it by the estimated cost to calculate total costs.

# Activity Based Costing - example

- If daily clean-up & set up is required 7-days per week @ a rate of \$400/day, then this fixed cost equals \$2800 per week [ $\$400 \times 7 = \$2800$ ].
- If product demand is brisk, and orders are processed 3-times per week [Mon, Wed & Fri] @ \$125 per order processing cycle, then this variable cost equals \$375 [ $\$125 \times 3 = \$375$ ].
- If product demand is slack, and orders are processed once per week [Monday] @ \$125 per order cycle, then this variable cost equals \$125 [ $\$125 \times 1 = \$125$ ].

# -Absorption & The Learning Curve-

## -The ABC of Frequency Rates-

**Absorption Costing is the “accounting basis” for the Learning Curve.** Doubling physical output results in a 50% reduction in per unit fixed costs, and between a 40% to 45% reduction in per unit total costs.

**ABC can be situational.** Fixed costs are just that – fixed. Even when we identify the specific cost driver or activity that generates that cost, it may be a necessary aspect of doing business in terms of a minimum frequency rate. Variable costs are a function of unit output. Higher unit production will generate increased variable costs and vice versa.

# Control

## -Tracking & Reporting Variance-

- **Unit Variance** (Efficiency/Usage)

$$[Q_s - Q_A] \times \text{Standard Cost per Unit}$$

$Q_s$  = Standard Quantity and  $Q_A$  = Actual Quantity

- **Cost Variance** (Price/Spending)

$$[C_s - C_A] \times \text{Actual Units Used}$$

$C_s$  = Standard Cost and  $C_A$  = Actual Cost

# CONTROL (Example)

## Deconstruction of Unit & Cost Variance

Cost in \$000 for Production Lot of 100 Aircraft

COST INPUT	UNIT VARIANCE	COST VARIANCE	TOTAL VARIANCE
Raw Material	<1,440>	1,125	<345>
Direct Labor	768	<381>	387
Variable Overhead	192	-0-	192
TOTAL COST	<510>	744	234



# ARSENAL OF DEMOCRACY: A Case Study in Mass-Assembly Line Production - The Consolidated B-24 Liberator -



# How Accounting & Mass-Assembly Line Production Took Flight in the B-24

- Absorption and Activity Based Costing plus Control were foundation for Planning & Budgeting in the Arsenal of Democracy
- Using this Accounting data, Operations Research (Critical Path, PERT, Shortest Route) techniques facilitated “economy of scale” production of WW II capital assets with the B-24 Liberator as the template
- Accounting was/is critical link in mobilizing Financial, Physical and Human Capital

# B-24 Liberator

-Most Widely Built Combat Aircraft in US History-

- Designed by Consolidated
- 18,500 total built by Consolidated, Douglas, FORD, and North American
- **FORD mass produced 8,600 (47%) via auto-industry mfr technology transfer**
- Used by all US and Allied air services in every theater thereby helping to win WW II
- Role: Heavy bomber, Anti-submarine warfare and Maritime patrol aircraft.



# B-24 Liberator's Differentiation

## -Adaptability and Capability-

- Four 1,200-hp Pratt & Whitney engines enabled long distance (3,000 miles range) with heavy loads (8,000+ pounds)
- This 30-ton aircraft could fly up to 300 miles an hour with a ceiling of 30,000 feet.
- Capable of high-altitude precision bombing at heights beyond range of anti-aircraft fire
- Fleet of B-24s completed 2,700 mile round trip to bomb enemy oil refineries (1943) in European theater – turning point in the war

# Auto-Industry Mfr Technology Transfer = Financial Success

- Op Profit Margin: 0.08 or 8%
- Unit cost per aircraft lowered by 43% from \$379,000 to \$216,000
- At height of production (1944) the *FORD plant produced one plane per hour* while *all other plants could only build one per day*
- FORD monthly output peaked at 650 units
- Technology transfer created through fusion of Accounting, Finance & Op Research

## EXAMPLE: Efficiency Gains from Auto-Industry Mfr Technology Transfer

- Special wing assembly methods reduced production time from 13-days to 1-hour
- Developing a fixture so fuselage section could be integrated with 55-foot center wing with minimal movement in one place
- Special forging department internally produced 7-million rivets per day in 520 different sizes

# Rosie the Riveter – The Ultimate Difference Maker



**“Rosie the Riveter” played a critical role during World War II**

# Vital Statistics of Willow Run Plant

- 2.5 million square feet in floor space; 3,200 feet long and 1,200 feet wide
- Mile-long assembly line
- Two 9-hour shifts per day / 42,000 workers
- 136 conveyors powered by 75 drive units
- Bridge conveyor fed fuselage sections similar to “drop” technique for autos
- Machine shops, runways, hangars, power plant, hospital plus employee housing



# **TQM (Total Quality Management) at FORD'S Willow Run Plant: Accounting, Finance & Operations Research in Action**



# LESSONS LEARNED

- Advancing the Future while Honoring the Past requires Integrity, Independence and Objectivity – the same characteristics for a successful Accounting Information System
- Accounting (due to its historic perspective) is basis for optimal Fin Decision Making
- Mass-assembly line production owes its success to effective use of Absorption and Activity Based Costing plus Control

# Closing Thoughts

- Consolidated B-24 Liberator (a microcosm of the WW II Arsenal of Democracy) is a classical case study affirming the role of Accounting principles used to implement Mass-assembly Line Production
- It is with profound gratitude and respect that this presentation is dedicated in blessed memory of all those connected with the B-24 Liberator



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# About the Speaker

- **George A. Haloulakos** is a Chartered Financial Analyst (CFA), university instructor, author and entrepreneur [DBA Spartan Research and Consulting] who provides strategic financial insights on various historic aircraft.
- George's signature books are *CALL TO GLORY*, an economic reappraisal of the Convair B-58 Hustler nuclear strike bomber, and *HIGH FLIGHT*, a compendium of case studies on various American and British aircraft from WW II through the Cold War.
- *CALL TO GLORY* (ISBN 9780692475454) and *HIGH FLIGHT* (ISBN 9780100727380) are available at: [www.ucsandiegobookstore.com](http://www.ucsandiegobookstore.com) or phone order 858-534-7326.
- Other books by George are *Dollars and Sense: A Workbook on the ABCs of Investments*, *Directed Studies in Advanced Financial Analysis* and *Case Studies in Financial Decision Making*. These titles are also available from the same source.