Measuring the Impact of PLM Phases I-III

Lisa Ncube, Ph.D.

Project Goal

The development of a metrics tool that organizations can use to assess the impact of PLM

Project Objectives

Provide a Access and Analysis
- Provide Roll up Capability of Metrics
- Provide Analysis models across the Data/ Information
- The ability to bring Metrics alive.
- Powerful Client Layer to Access Data

Provide an Application Model That Promotes:
- Hierarchical modeling of Manufacturing
- Provides a Consistent PLM Metrics Model
- Provides the ability to build Standards of Metrics and Approaches to Apply

Provide a System Platform on Which Metrics can be managed, and sustained. Integrated with Manufacturing.

Product Lifecycle Management Metrics

- Phase 1: Survey Instrument Development
- Phase 2: Exploratory Factor Analysis & Metrics Identification
  - Input Metrics
  - Output Metrics:
  - Outcome Metrics
  - Impact metrics

PLM Logic: Elements of the Model

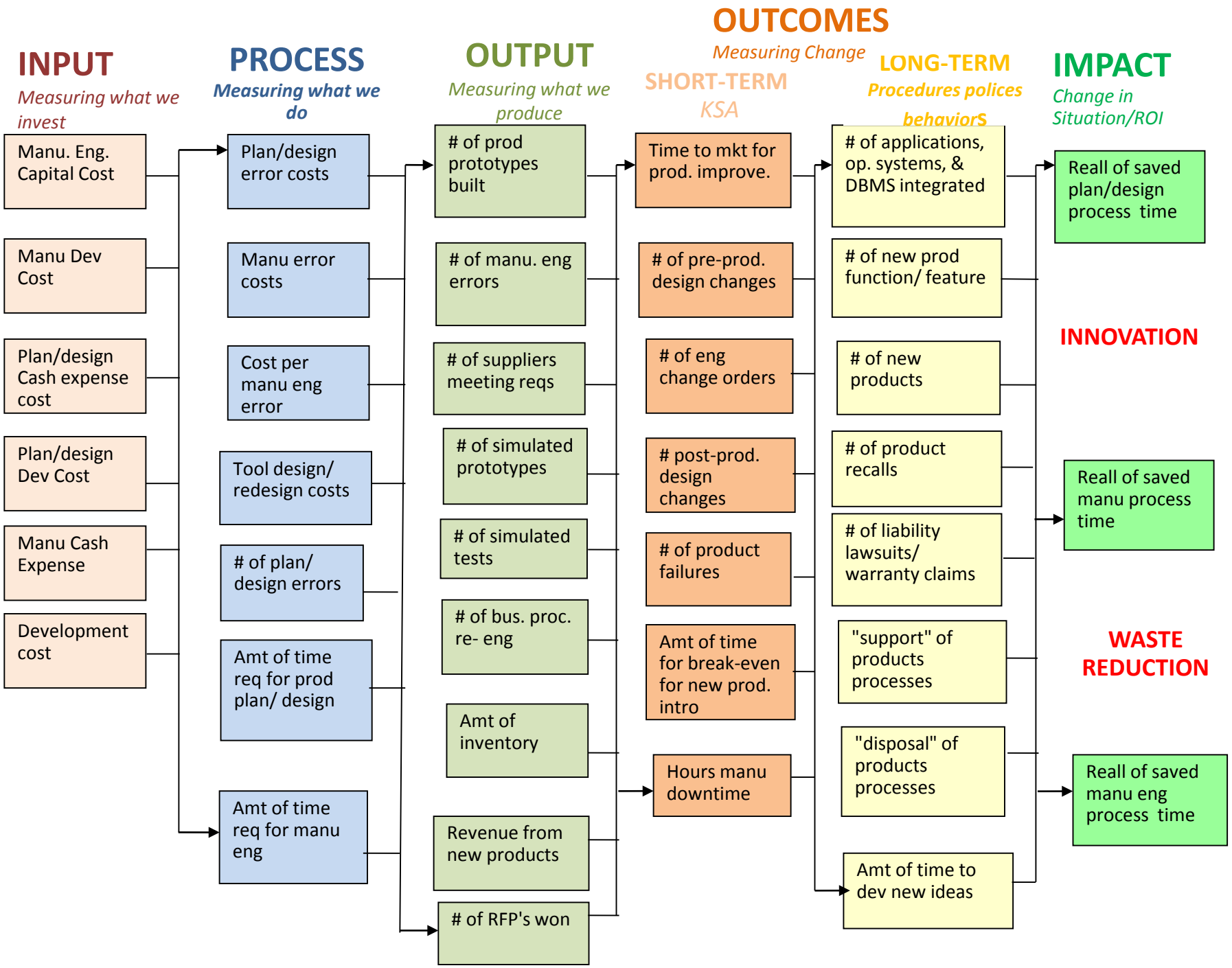
- Inputs Metrics: measure the quality of
  - Tactical investment in the existing business (balance optimization)
  - Strategic investment in new businesses (innovation) (Simmons 2000).
- Process Metrics: measure the quality of the company's PLM activities
  - Plan
  - Design
  - Build
  - Support

PLM Logic: Elements of the Model

- Outputs Metrics: are the product or service delivery/implementation targets for PLM:
  - Completion Performance,
  - Resource Optimization,
  - Change Control & Change Capacity,
  - Configuration Management Metrics, etc.
- Outcomes are the changes and/or benefits resulting from PLM activities and outputs:
  - waste reduction,
  - innovation and new products,
  - continuous improvement and
  - sustainable green manufacturing.
- Impact is the return on investment in strategic innovation of the PLM project.

How of PLM Program				*Results from Program*			
Resources/ Inputs *(What we invest)*	**Activities /Processes** (*What we do*)	**Outputs**	**Customers** *(Who we reach)*	**Short-term outcome/ Objectives** *(Change in: knowledge, skills, attitudes, motivation, awareness)*	**Medium-term outcomes/ Objectives** *(Change in: behaviors, practices, policies, procedures)*	**Long-term outcomes** *(Change in situation: environment, social, economic, political conditions)*	**I m p a c t**
Time **Energy** **Materials**	Initial ideation	Ideas & Concepts	Design Collaboration Team	Design reuse	Generation of new business	Waste reduction Innovation/ New Products Continuous Improvement Sustainable Green manufacturing	RETURN ON INVESTMENT
	Concept design	Design Capture & Accessibility	Engineers/ Designers	Virtualization	Improved corporate communication		
	Product design	Change Control & Change Capacity Configuration Management Metrics Commercial Cost of Risk	Engineers/ Designers	Faster time to production	Software integration		
	Manufacturing design	Product Development & prototype	Suppliers/ vendors	Cost reduction	Globalization		
	Production	Resource Optimization Product Quality	Engineers, Manufacturers	Cost performance Larger market share	Product quality		
	Delivery to the customer	Completion Performance	Wholesalers/ merchants/ vendors/ retailers	Premium pricing Increased profitability	Improved business cycle time Customer satisfaction Error reduction		
	In-service support	Portfolio Management	Customers	More efficient service to customers	Service quality Knowledge/ document management		
	Retirement from use.	Portfolio Management	Government Agencies: EPA	Environmentally friendly product disposal mechanisms	Sustainability		

EXTERNAL FACTORS INFLUENCING PERFOMCENCE (+/-)


INPUT
Measuring what we invest
PROCESS
Measuring what we do
OUTPUT
Measuring what we produce
OUTCOMES
Measuring Change
SHORT-TERM
KSA
LONG-TERM
Procedures polices behaviorS
IMPACT
Change in Situation/ROI
Manu. Eng. Capital Cost
Manu Dev Cost
Plan/design Cash expense cost
Plan/design Dev Cost
Manu Cash Expense
Development cost
Plan/design error costs
Manu error costs
Cost per manu eng error
Tool design/ redesign costs
# of plan/ design errors
Amt of time req for prod plan/ design
Amt of time req for manu eng
# of prod prototypes built
# of manu. eng errors
# of suppliers meeting reqs
# of simulated prototypes
# of simulated tests
# of bus. proc. re- eng
Amt of inventory
Revenue from new products
# of RFP's won
Time to mkt for prod. improve.
# of pre-prod. design changes
# of eng change orders
post-prod. design changes
of product failures
Amt of time for break-even for new prod. intro
Hours manu downtime
# of applications, op. systems, & DBMS integrated
# of new prod function/ feature
# of new products
# of product recalls
# of liability lawsuits/ warranty claims
"support" of products processes
"disposal" of products processes
Amt of time to dev new ideas
Reall of saved plan/design process time
INNOVATION
Reall of saved manu process time
WASTE REDUCTION
Reall of saved manu eng process time

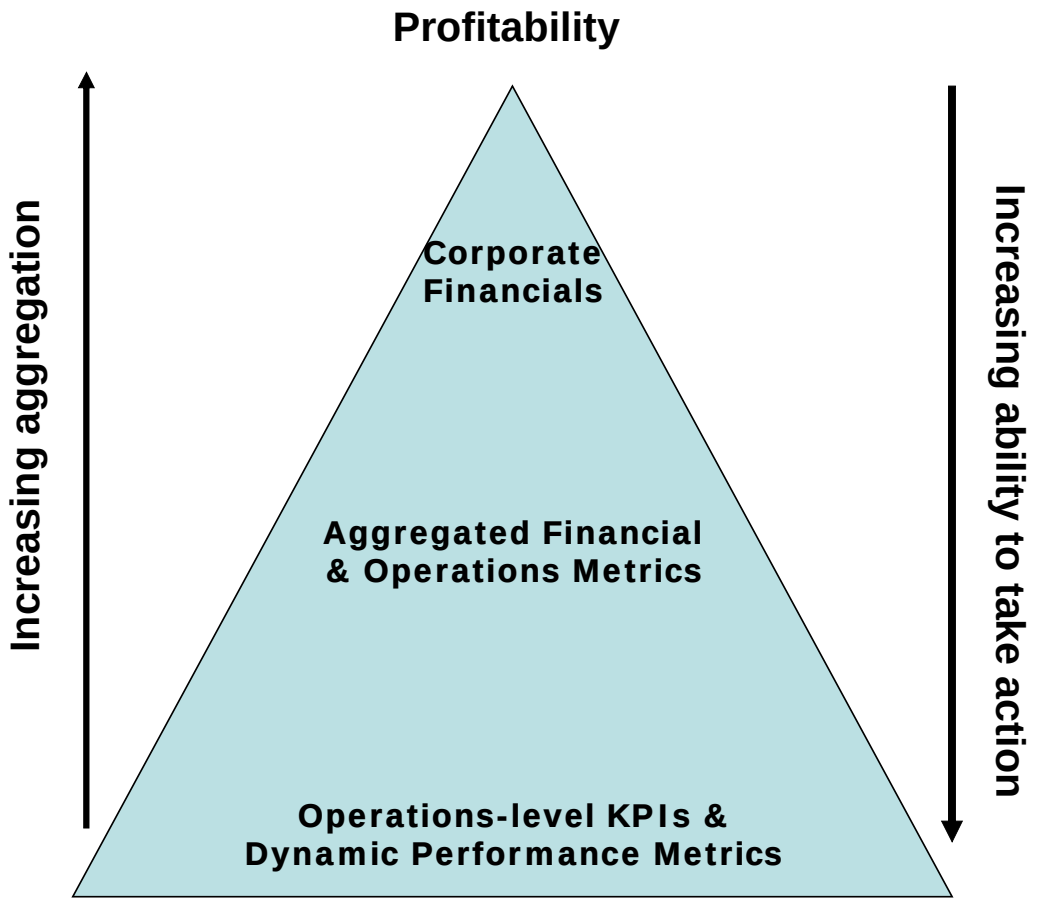
Phase 3: Confirmatory Factor Analysis & Heirachical Modeling

- Confirmatory phase: large-scale study Survey with ArcherGrey: est. 1500 respondents
- Multidimensionality of PLM
- Metrics validated
- Proof of concepts as represented by data & publications

Hierarchical Modeling

- Also known as multilevel modeling, empirical Bayes, random coefficient modeling, or growth curve modeling
  - allows for the organization into a hierarchy of the lowest-level units (smallest and most numerous) as successively higher-level units.
- identify of factors affecting performance and their relationships,
- structuring the factors hierarchically,
- quantify the effects of the factors on performance.

Hierarchical Metrics Framework



Audience:

CFO, CEO

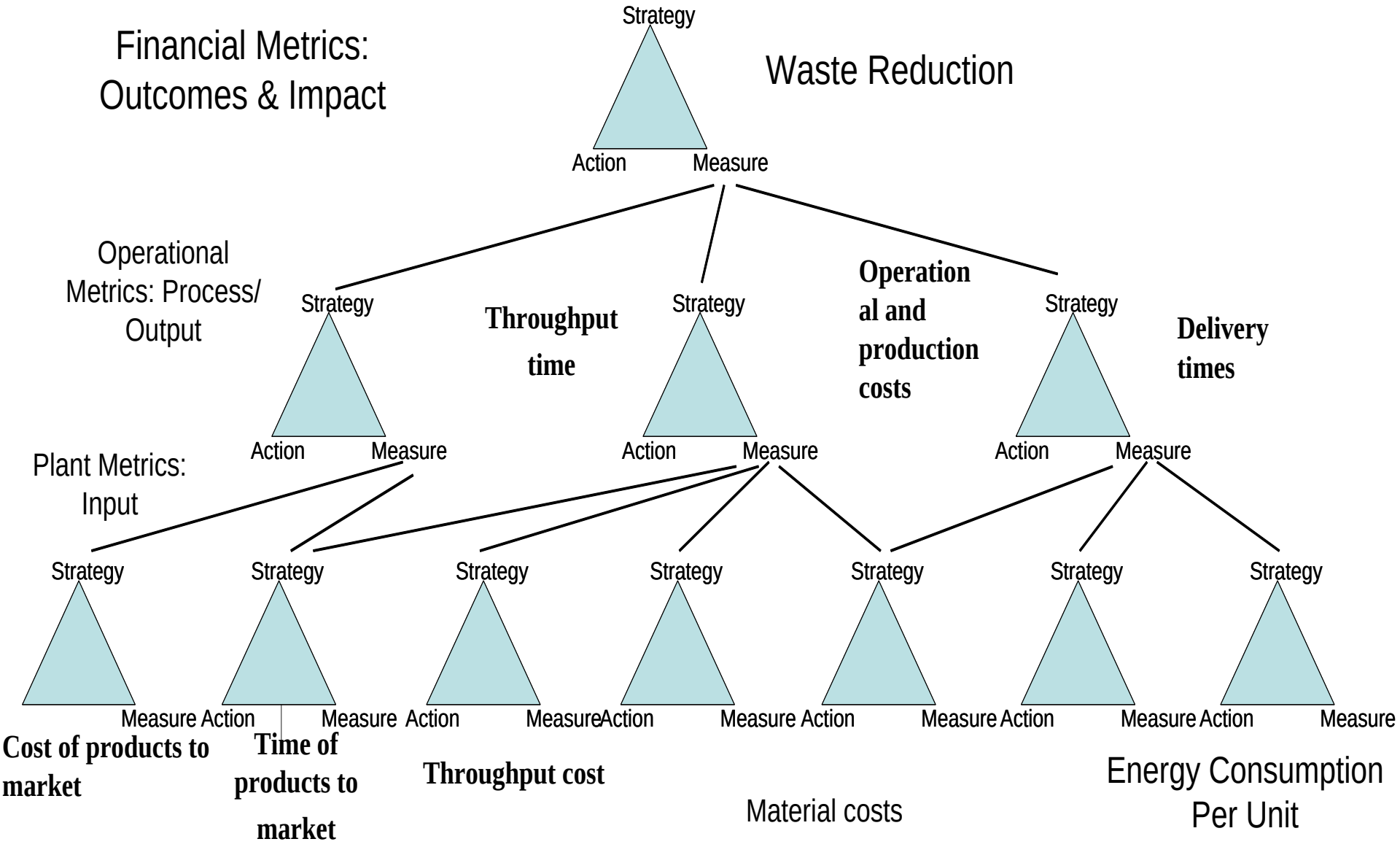
Plant Accounting, Finance

Plant Management, Operations Management

Operators, Supervisors, Quality, Engineers, Technicians

Source: *Metrics that Matter Guidebook & Framework*

PLM Corporate Strategy: Waste Reduction & Innovation



Metric	Subcategory	Formula
Cost of products to market	Cost of products to market Product's research & dev cost Engineering design cost Product investment cost Product dev & testing cost Cost of quality	Cr= [C_{nn} + C_{rr} + C_{rc} + C_{rt} + c_{rd} C_{nn} = Design management cost C_{rr} = Advanced R & D cost C_{rc} = Engineering design cost C_{rt} = Product dev & testing cost C_{rd} = Engineering data cost
Total throughput cost	Procurement cost Non-recurring manuf. cost Recurring manufacturing cost Facilities cost Initial logistics support cost Cost of quality	New facilities, spares, support equip. acquisition, system recurring acquisition, data, initial training, training equip., production tooling & test equip., production program start-up, initial item mgt, field eng, equip. installation.
Operational & materials cost	Cost of quality Operations cost Maintenance cost Product modification cost Product phase-out & disposal cost	C_{oo} = [C_{oop} + C_{oot} + C_{oof} + C_{ooe}f4 C_{oop} = Operating personnel cost C_{OOl} = Cost of operator training C_{oof}= Cost of operational facilities C_{ooe} = Cost of support & handling Dowlatshahi, 2001

Metric	Subcategory	Formula
Time of new products to market	Speed of response to customers (SRC) Product time to market (PTM) Design lead time (DLT) Order-to-delivery cycle (OTDC) Total product delivery lead time (TPDLT)	DLT = Σ (Time from product concept to product design+time from product design to prototype) TPDLT = Σ (Design lead time + supplier delivery lead time + manufacturing lead time + distribution lead time + order lead time)
Total throughput time	Manuf. lead time (MLT) Set-up time (SUT) Prod. cycle time (PCT) Change over time (COT) Delay time (DT) Distribution lead time (DILT) Manuf. response time (MRT) Procurement lead time (PLT)	MLT = L (Time from receipt of an order to the start of manufacturing + time from start of manufacturing to entry into the distribution system)
Delivery time of purchased materials	Delivery reliability (DR) Delivery speed (DS)	DR = Measured in terms of the percent of orders delivered by the promise date Dowlatshahi, 2001

Ongoing Work

- Development of a Balanced PLM Metrics Score Card

A BALANCED FRAMEWORK FOR METRICS

Understanding the Financial Metrics and What affects them in Manufacturing

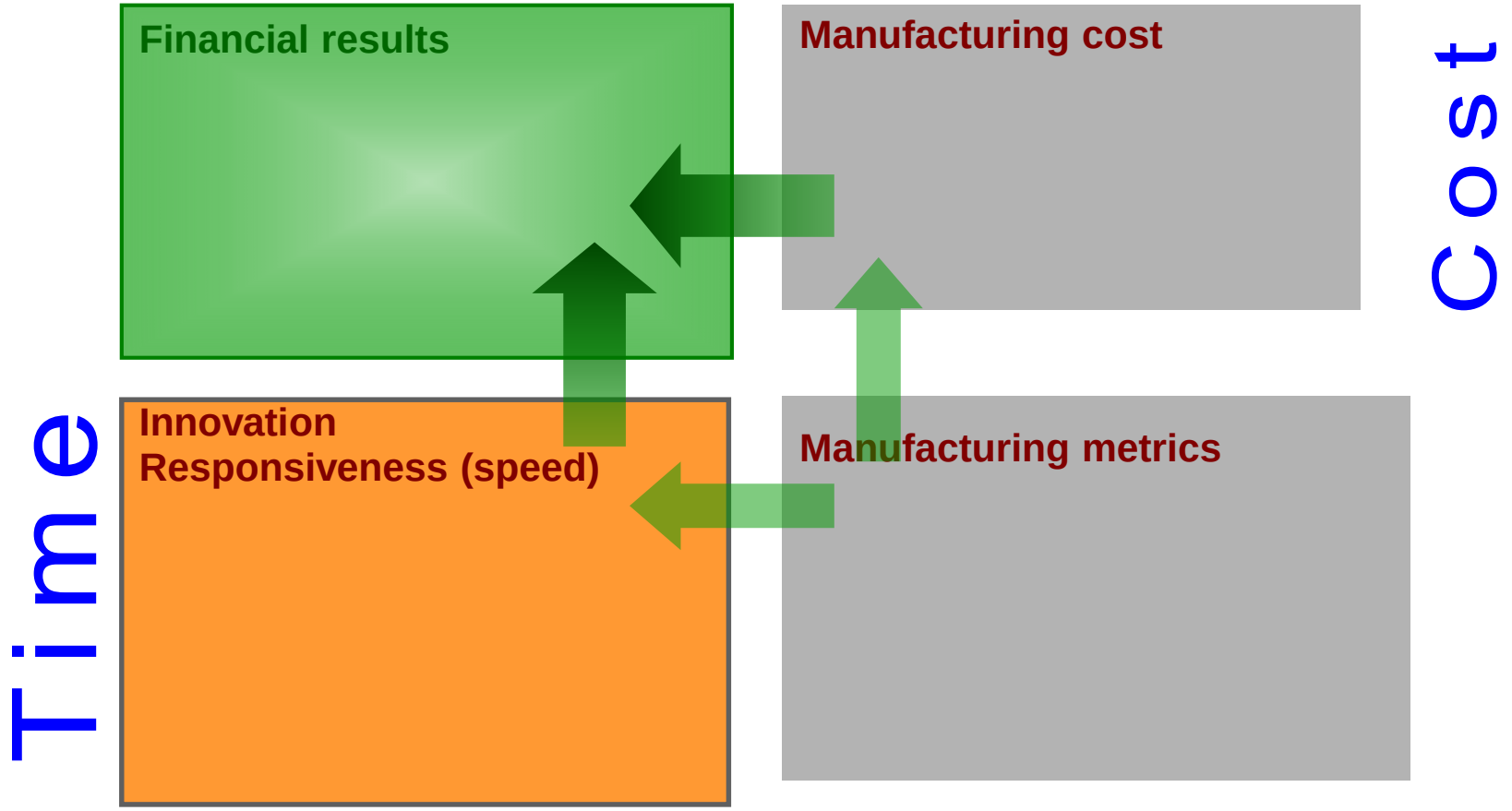
Logical Steps to using Metrics Alignment in order to Achieve Manufacturing Excellence

What Metrics are in a Balanced Score Card?

- The Score Card includes a balanced view of an organization
  - Learning and Growth
  - Customer Relations
  - Internal Processes
  - Financial Measures

Balanced Metrics Framework

Manufacturing costs are more closely related to financial results than manufacturing metrics



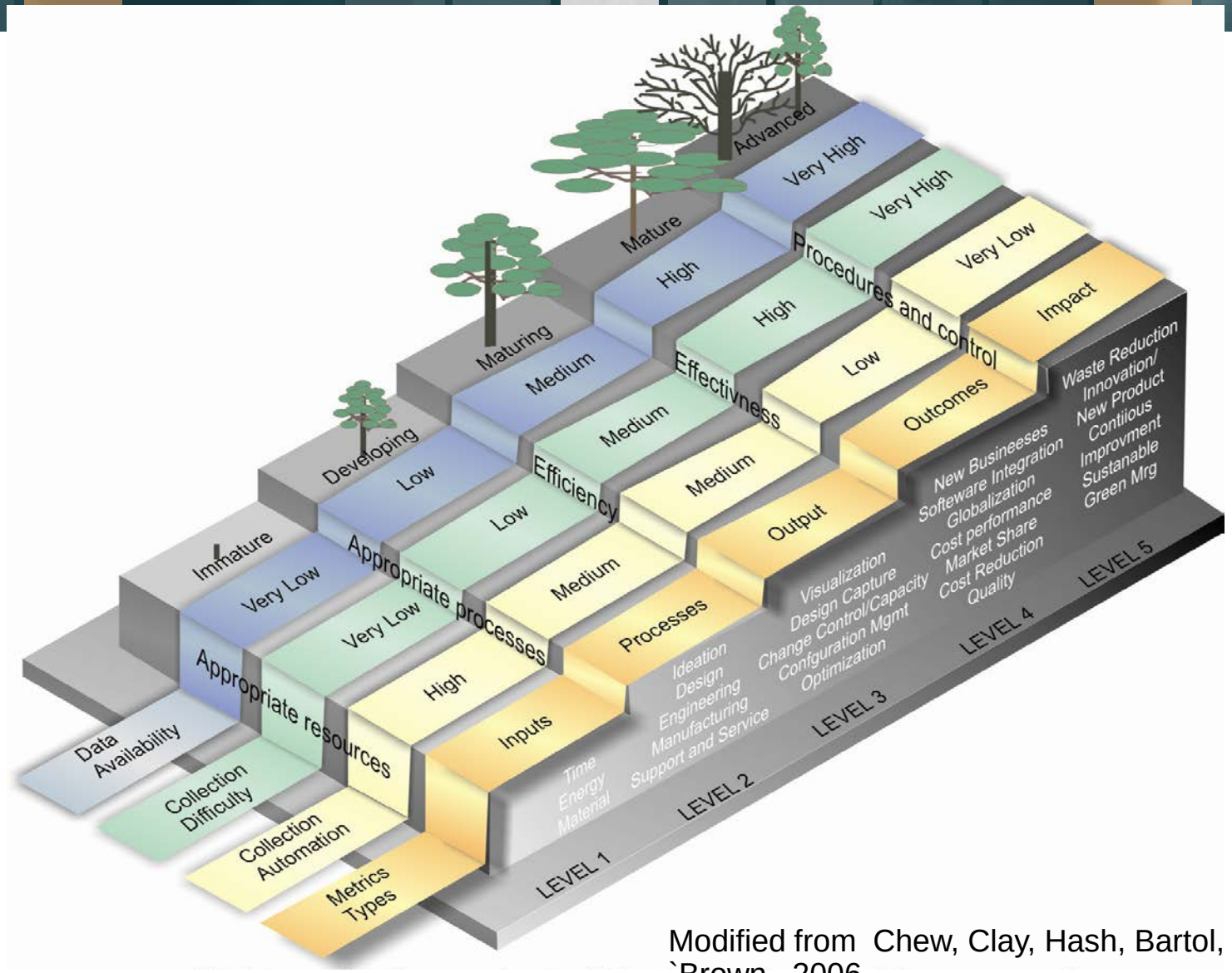
Future Work

- Development of Product Lifecycle Implementation Maturity Model

Product Lifecycle Implementation Maturity Model

- Implementation metrics are used to demonstrate progress in implementing PLM.

Product Lifecycle Implementation Maturity Model



Modified from Chew, Clay, Hash, Bartol, `Brown , 2006

Product Lifecycle Implementation Maturity Model

- Level 1: the focus is on appropriate resources and processes.
- Level 2: Established performance management processes to measure processes: Efficiency & effectiveness metrics.
- Level 3: Companies should be measuring their outputs
- Level 4: Collection of detailed measures of the product quality
- Level 5: Optimizing, continuous process improvement

Future Work

- Field Testing: Testing & Validating Metrics Framework
- PLM Metrics 2.0

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