QUICK REFRENCE

TO

MATERIAL FLOW COST ACCOUNTING

(ISO 14051)

National Productivity Council

This guide has been prepared to provide basic knowledge and understanding of material flow cost accounting (MFCA). It intends to be a quick handheld guide that is comprehensive, up to date, and consistent with ISO 14051.

It is recognized that:

- This guide is not intended to be the one and only guide on learning and applying MFCA.
- Gaining practical experience through project implementation after formal training will greatly increase the speed and level of competency.
- Sole reliance on the guide is not advisable.

MFCA in Nutshell

MFCA is one of the major tools for environmental management accounting and promotes increased transparency of material use practices through the development of a material flow model that traces and quantifies the flows and stocks of materials within an organization in physical and monetary units.

It is a method of environmental management accounting that simultaneously achieves **“reduced environmental impacts”** and **“improved business efficiency.”**

MFCA FOCUSES ON REDUCING THE MATERIAL WASTAGE AT SOURCE

- ✓ **Combines the concept of Process Efficiency & Environmental Performance.**
- ✓ **Focuses on Optimal resource utilization.**
- ✓ **Improves material efficiency.**
- ✓ **Contributes towards improvement of energy efficiency.**
- ✓ **Overall Cost reduction & increase in Profitability.**

The method was originally developed in Germany and has been further developed in Japan. The inclusion of MFCA in the International Organization for Standardization (ISO) was an initiative from Japan. ISO 14051 was issued in 2011.

MFCA measures the flow and stock of all materials in the manufacturing process in both monetary and physical terms. The materials include raw materials, parts, and components. MFCA analysis provides an equivalent comparison of costs associated with products and costs associated with material losses, for example, waste, air emissions, wastewater, etc.

Mostly an organization is unaware of the full extent of the actual cost of material losses because data on material losses and the associated costs are often difficult to extract from conventional information, accounting, and environmental management systems and these can easily be visualized by adapting to MFCA implementation.

MFCA in Nutshell

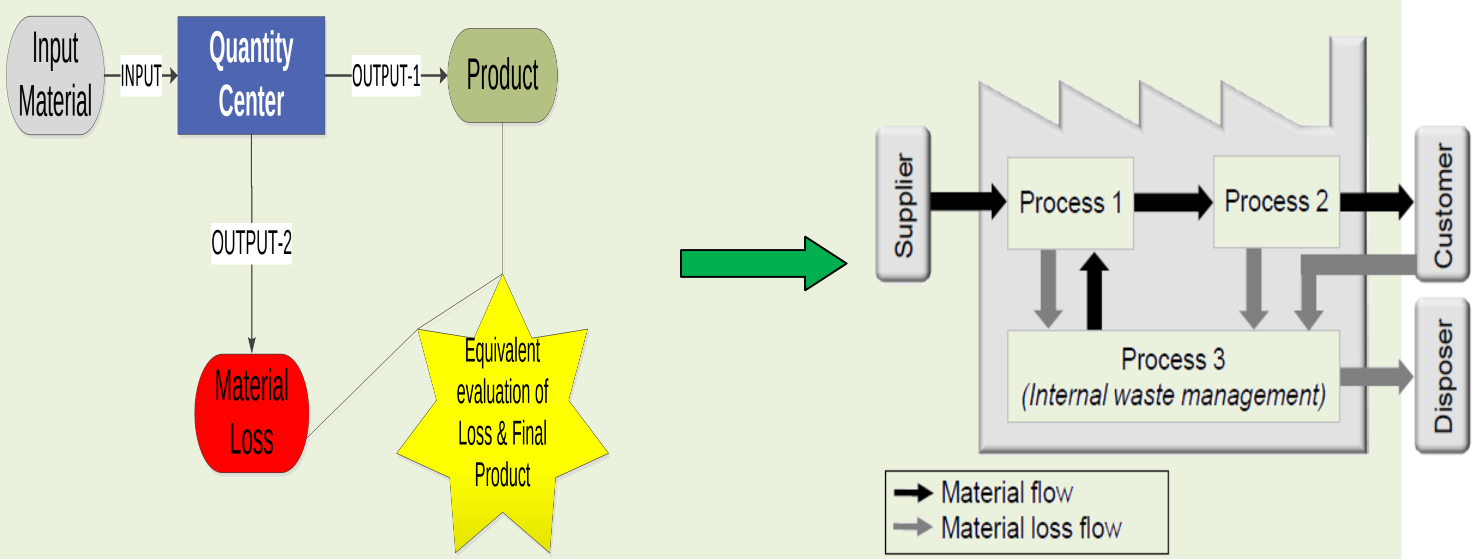
MFCA makes you to consider waste.

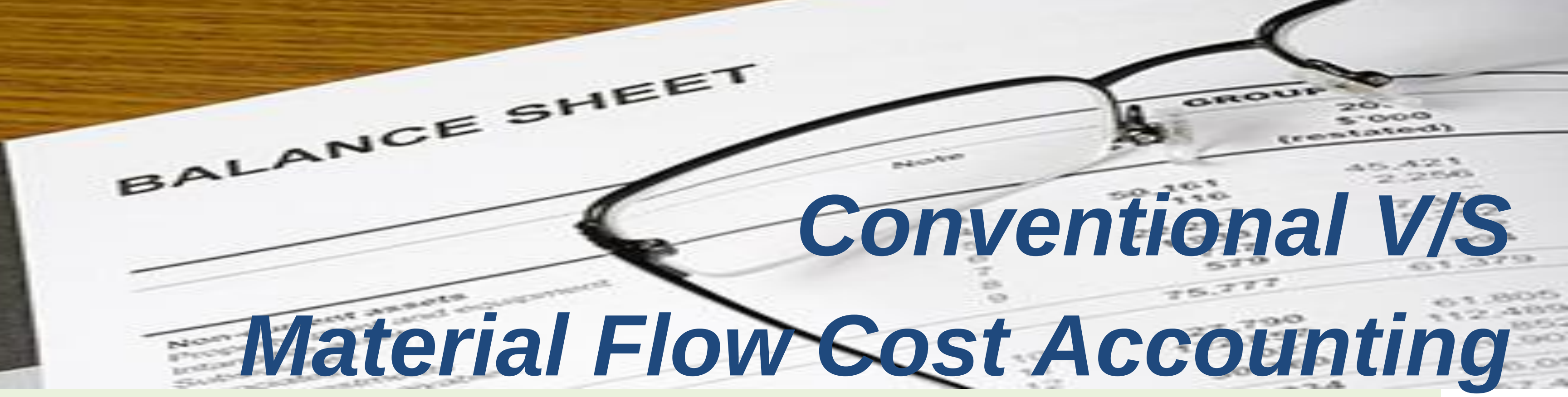
MFCA potentially enables you to have a bigger apple with thinner skin.

A paradigm shift regarding thought of waste.

MFCA focuses on identifying the wastes by using concepts of material balance at different quantity centres of the process/operation.

MFCA: Material Balance approach





Conventional V/S Material Flow Cost Accounting

MFCA represents a different way of management accounting. In conventional cost accounting, the data are used to determine whether the incurred costs are recovered from sales. It does not require determining whether material is transformed into products, or disposed of as waste. In conventional accounting, even if waste is recognized in terms of quantity, the costs to produce "material losses" are included as part of the total output cost. On the other hand, **MFCA focuses on identifying and differentiating between the costs associated with "products" and "material losses."**

Material loss is evaluated as an economic loss, which encourages the management to search for ways to reduce material losses and improve business efficiency.

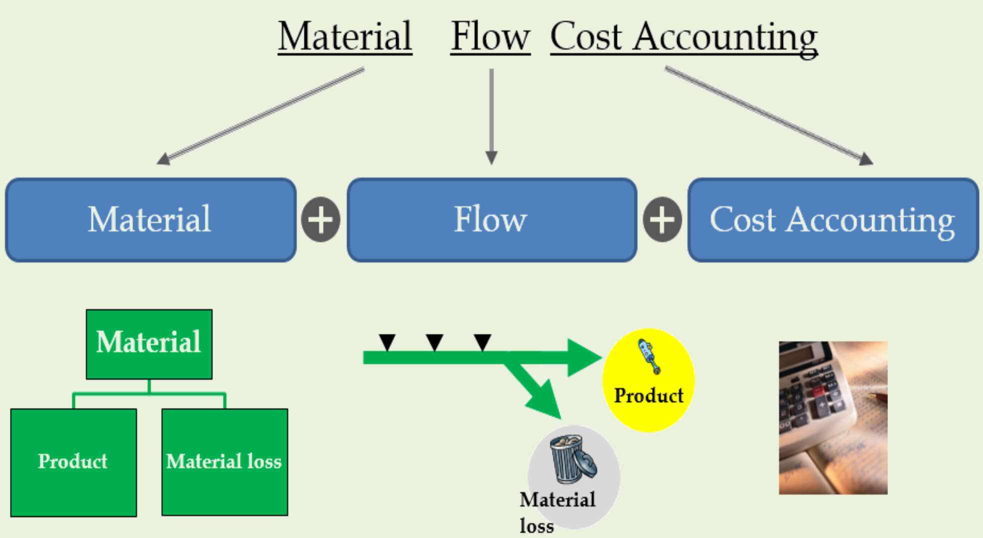
Table 1 : *Difference between MFCA and Conventional Accounting*

MFCA highlights costs associated with material loss

MFCA		*Conventional Accounting*	
Sales	***15,000,000***	***Sales***	***15,000,000***
Product Cost	***3,000,000***	***Product Cost***	***4,500,000***
Material Loss Cost	***1,500,000***	***N/A***	***N/A***
Gross Profit	***10,500,000***	***Gross Profit***	***10,500,000***
Selling, General and Administration expenses	***8,000,000***	***Selling, General and Administration expenses***	***8,000,000***
Operating Profit	***2,500,000***	***Operating Profit***	***2,500,000***

The differences between MFCA and conventional accounting do not mean that MFCA cannot be applied to any organization that uses materials and energy. In other words, MFCA does not demand any specific requirement in regard to type of product, service, size, structure, or location.

Basic Terminology related to MFCA



4 main elements of MFCA:

- ✓ ***Material*** in any form.
- ✓ ***Flow*** as per process sequence.
- ✓ ***Associated cost*** of materials as per the process flow
- ✓ ***Material Flow Model,*** visual representation of the process that shows all the quantity centres

.

Material

Material refers to any raw material, auxiliary material, component, catalyser, or part that is used to manufacture a product. Any material that does not become part of the final product is considered material loss. In any process, waste and resource loss occur in different steps of the process, including:

- Material loss during processing, defective products, impurities
- Materials remaining in manufacturing equipment following set-ups
- Auxiliary materials such as solvents, detergents to wash equipment, water
- Raw material that becomes unusable for any reason

Flow

MFCA traces all input materials that flow through production processes and measures products and material loss (waste) in physical units using the following equation:

Input = Products + Material loss (waste)

The starting point of MFCA is to measure amount of material losses based on mass balance. The concept is illustrated in above figure. In this case, the amount of the material loss (30 tons) is calculated based on the amount of total input and products in a selected part of a process in which the inputs and outputs are quantified. This part of the process is defined as a quantity centre in MFCA.

Basic Terminology related to MFCA

Cost Accounting

Under MFCA, the flows and stocks of materials within an organization are traced and quantified in physical units (e.g., mass, volume) and then assigned an associated cost. Under MFCA, four types of costs are quantified: material costs, system costs, energy costs, and waste management costs. Each cost is defined as follows:

Material cost: Cost for a substance that goes through a quantity centre (measurement unit of input and output for MFCA analysis). Typically, the purchase cost is used as material cost.

Energy cost: Cost for energy sources such as electricity, fuels, steam, heat, compressed air.

System cost: Cost incurred in the course of in-house handling of the material flows, excluding material cost, energy cost, and waste management cost.

Waste management cost: Cost for handling material losses.

Following identification of a physical unit for material flow data, material costs, energy costs, and system costs are subsequently assigned or allocated to quantity centre outputs (i.e., products and material losses) based on the proportion of the material input that flows into product and material loss.

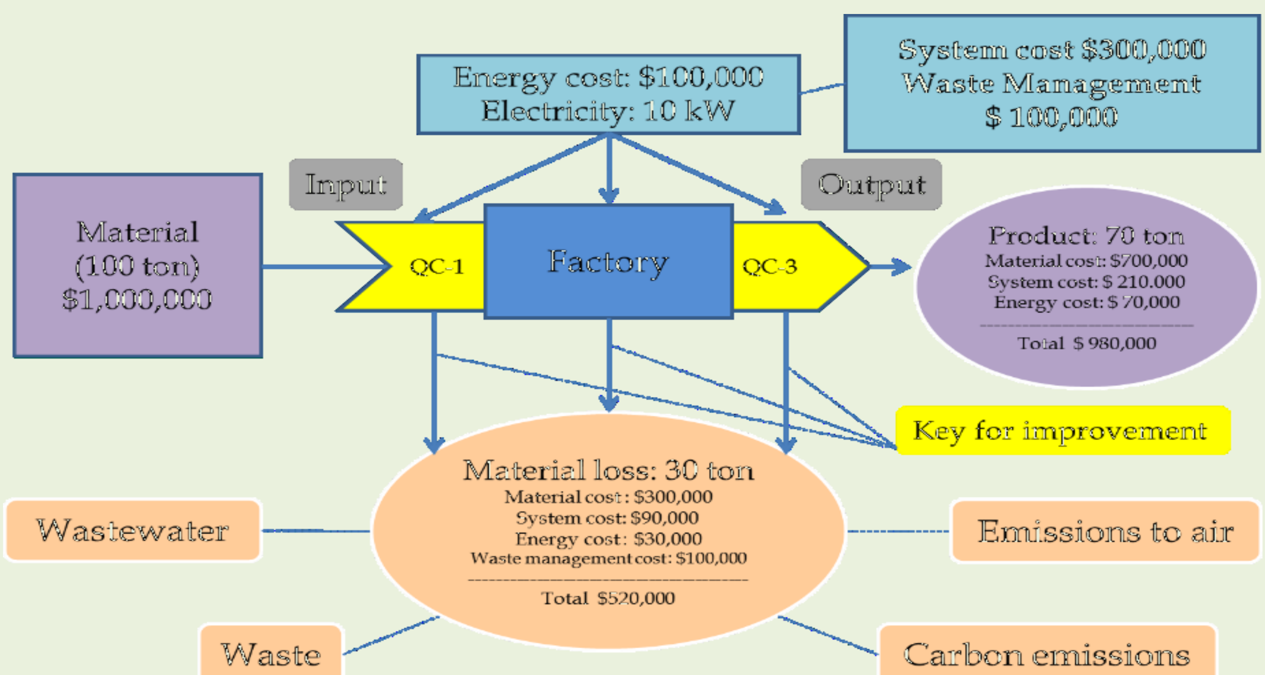
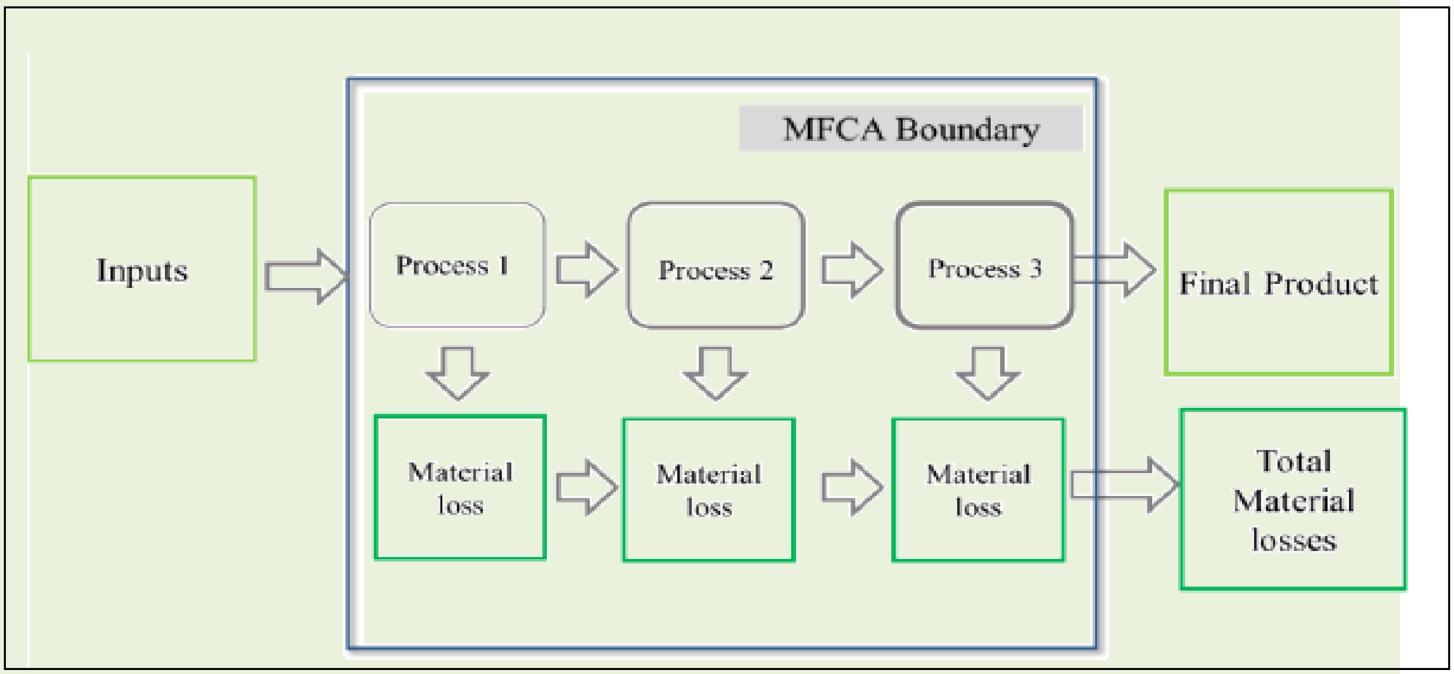


Figure 1 : Illustration of MFCA evaluation in monetary terms

Basic Terminology related to MFCA

Material Flow Model

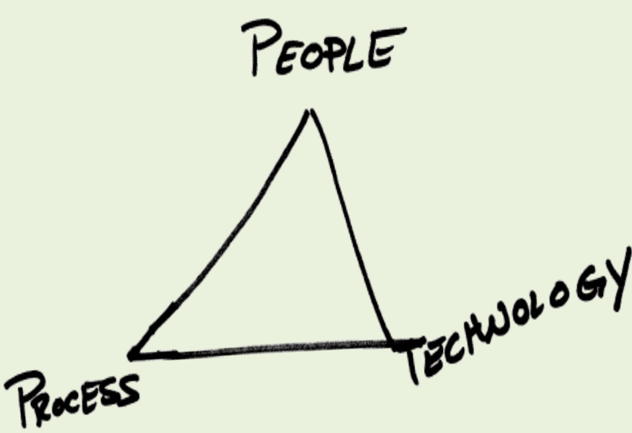
It refers to the visual representation of the process that shows all the quantity centres in which the materials are transformed, stocked, or used, as well as the flow of these materials within the system boundary. Figure below shows an example of a material flow model.



Implementing MFCA in your organization

*I*mplementation of MFCA requires application of Plan-Do-Check-Act Cycle to clarify direction, increase learning, aligning efforts and improving results to achieve the overall MFCA goals of **“reduced environmental impacts”** and **“improved business efficiency.”**

Secrets of Successful MFCA Implementation



3 PILLARS OF PROGRAMME MANAGEMENT

Implementation of MFCA

PDCA Cycle for MFCA Implementation

9 Step PDCA Cycle for MFCA Implementation

PLAN

- Top Management awareness & Support for Programme Implementation
- Locating/Finding the Expertise Requirement
- Building a Guiding Coalition within the organization.
- Specify the Implementation Boundary
- Defining the Quantity Centers

DO

Develop Material Flow Model which shall include following :

Identification of Inputs & outputs for each quantity centers.

Quantification of material flows in physical Units.

Quantification of Material flows in monetary units.

CHECK

- Summarizing the data and Interpretation of MFCA Results
- Communication of MFCA Results

ACT

- Identifying and Assessing the Improvement Opportunities

Implementation of MFCA

PLANNING:

Getting started for MFCA

As shown in the above PDCA cycle, the first three steps of PLAN phase focuses on building the ***awareness ,capability and acceptability*** in the organization for implementation of the MFCA Programme. The *involvement of management* and the *determination of necessary expertise* can be seen as initial key steps within the PLAN module.

Building a guiding coalition helps to create acceptability within the organization which help to create a base of and availability of skills for further steps of implementation of MFCA.

After achieving awareness, capability and acceptability in organization, the next two steps of the PLAN module are parts of flow structure modelling.

For the modelling of material and energy flows system boundaries have to be specified. Basically, the boundaries can span a single or several process (es), the whole organisation or even entire supply chains. As a base for structured analysis the decomposition into subsystems might be useful .Furthermore, the specification of a *time period* is necessary for getting significant data, the time period should be sufficiently long. Thus, seasonal fluctuations and inherent process variations can be recognised and factored in interpretations of data. Time period can be, for example, a month or a year or the time which is needed for the manufacturing of a production lot.

The final planning step within PDCA-Cycle is the determination of quantity centres. Quantity centres are spatial or functional units which store process or otherwise transform materials (such as material storages, production units, outgoing good storages or disposal systems) and which are connected by material flows. P*rocesses,* such as receiving, cutting, assembling, heating and packing, etc. can be defined as quantity centres as well as material storages.

DO:

Journey for MFCA starts now

As the first "DO"-step, for each quantity centre inputs (e. g. materials, energy) and outputs (products, material and energy losses) have to be identified.

The quantification of material flows is the second step of the DO module. Based on the flow structure, material flows have to be *quantified in physical units* such as mass, length, volume or number of pieces. By using a single standardised unit (e. g. mass), for every quantity centre a material balance can be created.

Within the last step of the DO module, material flows are quantified in terms of monetary units (as so-called flow costs) and in order to evaluate them, the costs are differentiated into material, energy, system and waste management costs.

Material costs, have to be calculated "for a substance that enters and/or leaves a quantity centre" and, thus, for products as well as for material losses.

Energy costs are costs for electricity, fuels, steam, heat, compressed air and others. They should be calculated for each quantity centre on the basis of the measured or estimated energy use. If energy use cannot be measured or estimated for individual quantity centres, total energy use can be allocated to the (Output of) quantity centres on base of the mass criterion for means of simplification.

System costs*, represent* all costs for handling in-house material flows except for material costs, energy costs and waste management costs.

For example, this includes costs of labour, depreciation, maintenance and transportation. In the case that system costs cannot be calculated for single quantity centres but only for organisational units, they could be allocated on the basis of suitable criteria such as machine hours, production volume, number of employees, or floor space.

Finally, waste management costs are costs "of handling material losses generated in a quantity centre". Waste management includes the management of air emissions, wastewater and solid waste. Waste management costs are costs for internally or externally executing activities like reworking of rejected products, recycling, waste tracking, storage, treatment or disposal.

Implementation of MFCA

Consider a process involving Dissloving, casting and cutting. The visualization for Material flow diagram for the same can be shown below:

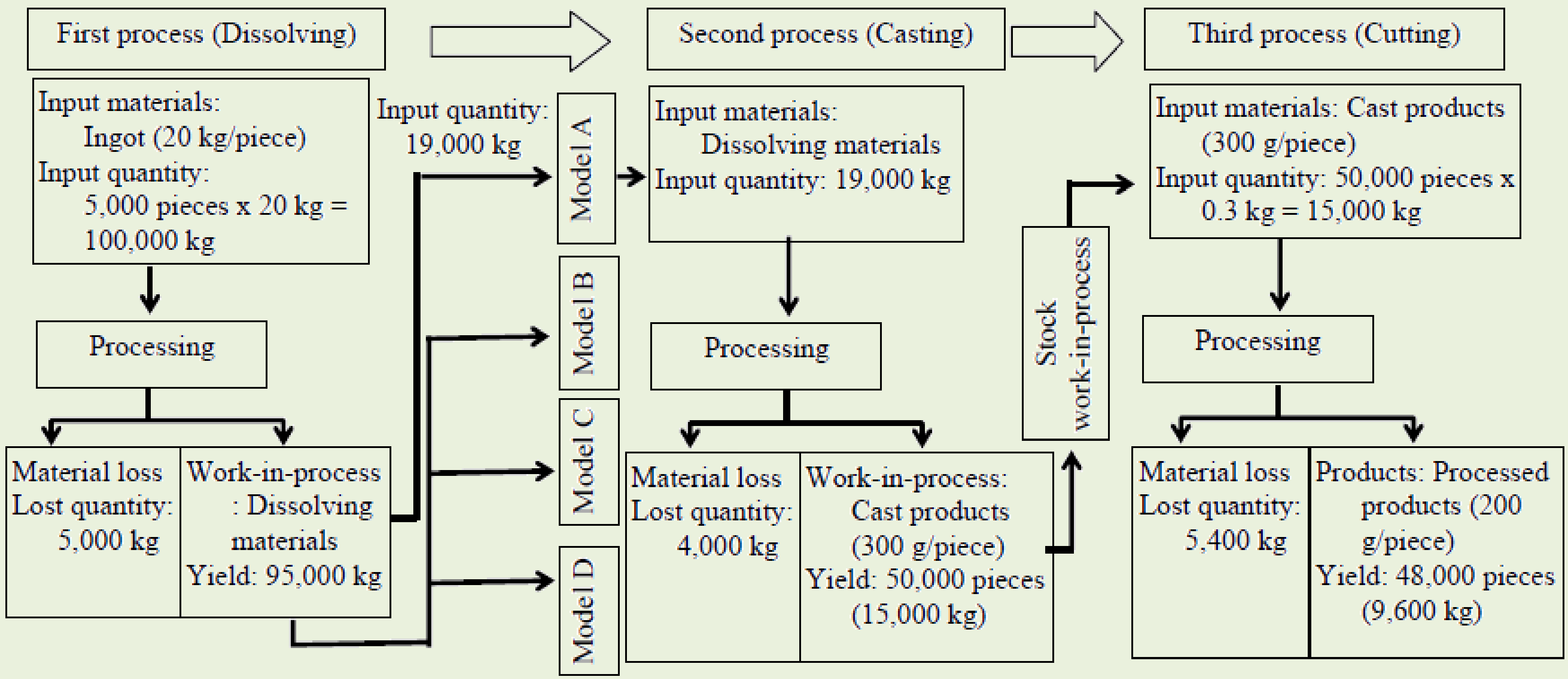
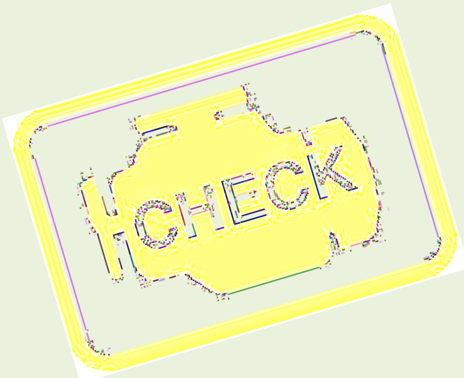


Figure 2 : Illustration of material flow model for MFCA

Implementation of MFCA

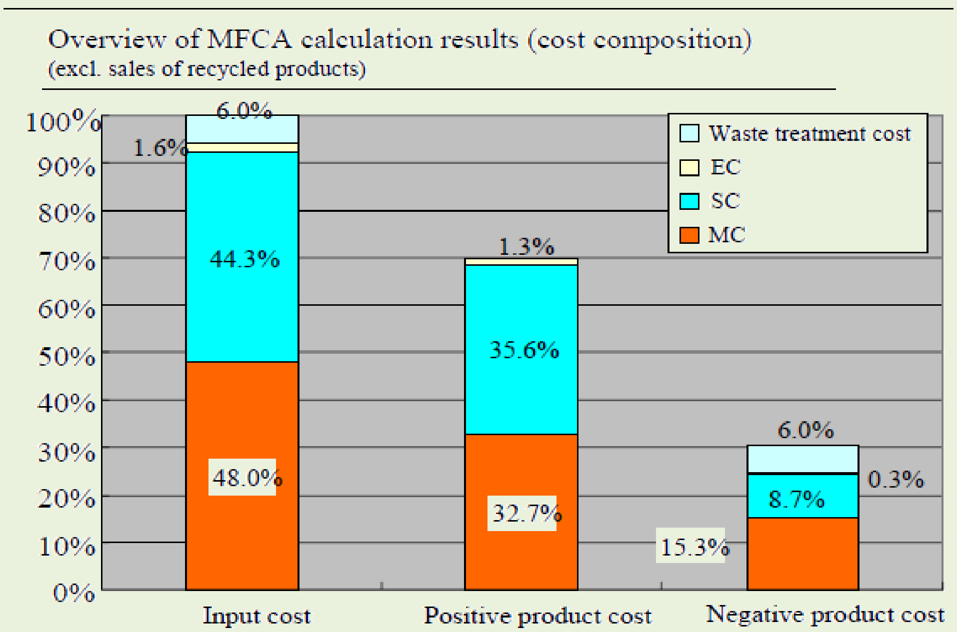


The CHECK module of the PDCA-cycle concludes the *MFCA data summary and interpretation*, e. g. using material balances, material flow cost matrices.

A chart combining positive and negative product costs throughout all the processes based on the above flowchart including calculation data is called a “material flow cost matrix.”

	Material cost	Energy cost	System cost	Waste treatment cost	Total
Conforming products	16,660	657	18,136		35,452
(Positive products)	32.7%	1.3%	35.6%		69.6%
Material loss	7,806	162	4,441		12,409
(Negative products)	15.3%	0.3%	8.7%		24.4%
Wastes/recycled products				3,076	3,076
				6.0%	6.0%
Subtotal	24,466	819	22,576	3,076	50,937
	48.0%	1.6%	44.3%	6.0%	100.0%

Table 2 : Material Flow Matrix representing the data of material flow diagram as represented in figure-2

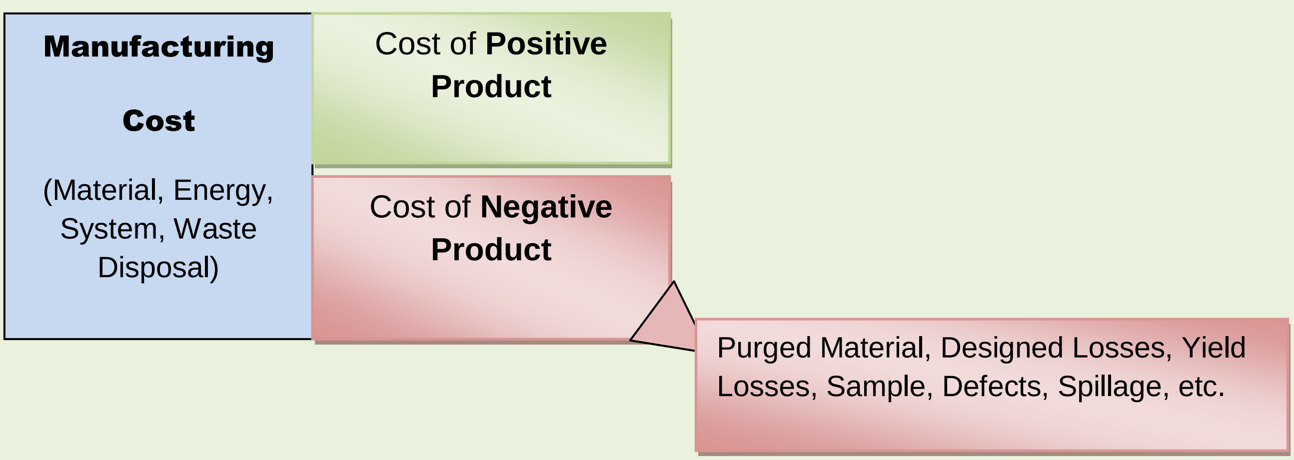


Implementation of MFCA

***B**ased on the created transparency of material and energy flows, finally, *improvement opportunities* for reducing wastage have to be *identified and assessed* within the ACT phase and decisions regarding the implementation of improvement opportunities have to be made before the cycle starts again.

Conduct Loss analysis to identify the negative product cost by following breakdown:

- *Type of negative product.*
- *At each individual quantity center*
- *Type of losses*
    - ❖ ***Theoretical losses :** Design, Solvent Medium, Edge of Jumbo Roll, etc*
    - ❖ ***Normal Losses :** Set-up, Trial Running, Cleaning, Sample, etc*
    - ❖ ***Avoidable Losses:** Poor Workmanship, Spoilage, Spillage, Defective Unit, Rework, etc.*



Implementation of MFCA

Illustration of Loss Analysis Table

Sr. No.	***Quantity Centre***	***Waste / Loss***		***Loss Type***			***Source of Waste Generation***
		Quantity	***Cost***	***Theoretical Losses***	***Normal Losses***	***Avoidable Losses***	

Format table for improvement requirements

Quantity Center	***Loss Type***	***Loss Description***	***Loss Scale***	***Direction & Focus of Improvement***	***Identified Constraints***	***Improvement Theme***	***Targets***	***Expected Benefits***

Some Tools for generating MFCA Kaizens

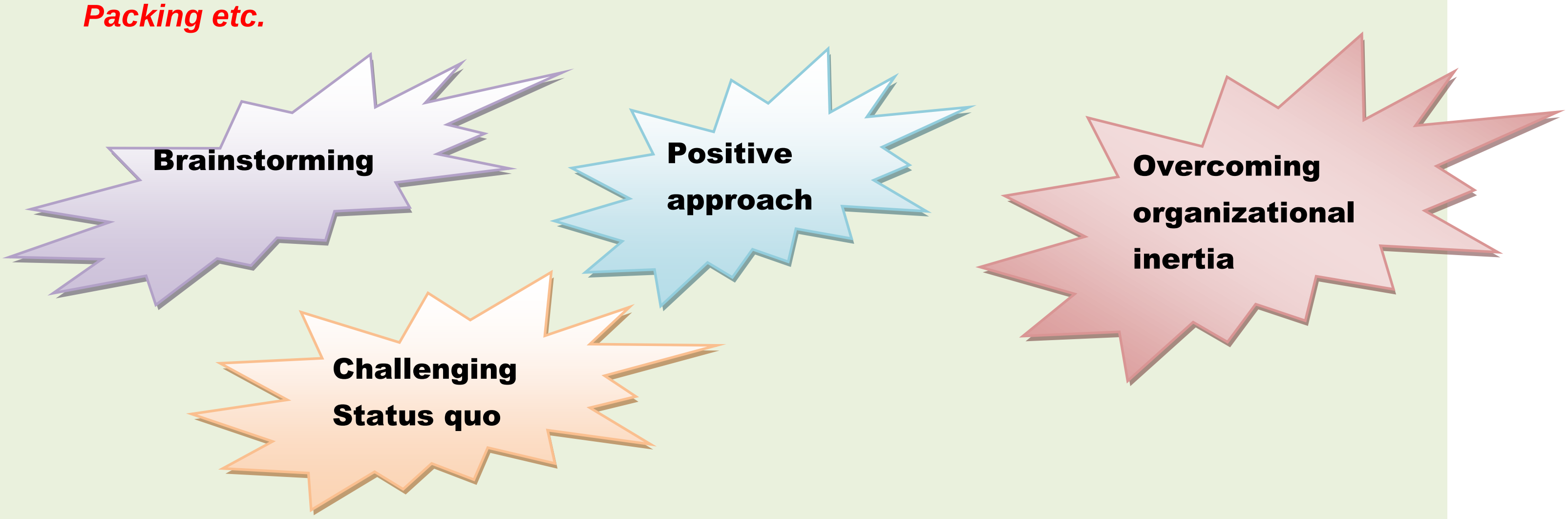
Value Engineering/Analysis:

- Most Suitable for material intensive industry.
- Method for improving the product/process value by relating the elements of product/process in order to achive the final product with desired function with minimum cost.
- Value is an abstract term i.e it can neither be seen or touched but can only be understood.
- But as any improvement exercise needs some numerical value or connotation, therefore the value for any process or item is quantified using the parameter called Function which is actually what a product does , expressed in terms of Rupees.
- In value Engineering/Analysis, value is expressed as *:*

  VALUE = FUNCTION / COST

  > *E.g. - If there are two 2 pens A and B ; Pen A costs Rs.10 and Pen B costs Rs.20 and the function of pen is considered to be only writing ;the cost of function is to be Rs.10 only.*
  >
  > *Then,*
  >
  > *Value of Pen A - 10/10 = 1*
  >
  > *Value of Pen B – 10/20 = 0.5*
  >
  > *Kindly note that in above example only function for pen considered is writing only while there might be other functions also which may need to be analyzed while doing real world analysis.*

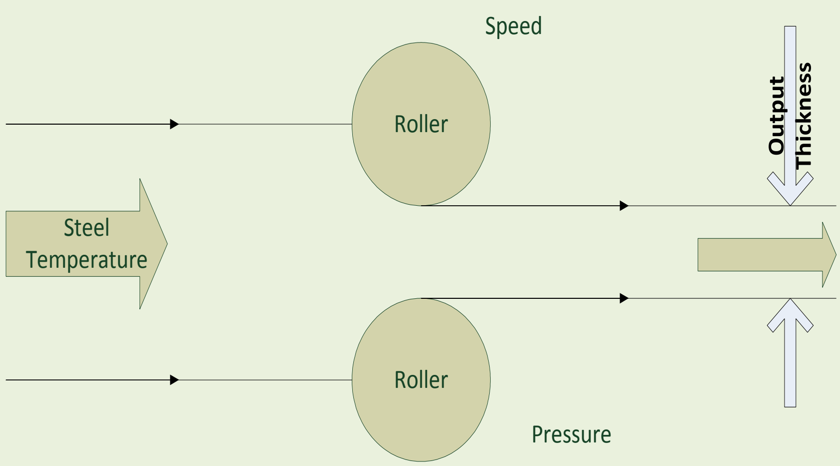
Sometimes value of a process or product can be optimized by simple ideas on optimizing Tolerances, Finishes, Allowances, Multiple Testing and excessive paper works, Excessive Packing etc.



Design of Experiments

- ***It is basically a*** statistical tool which requires detailed understanding before it can be applied with statistical validity therefore, it is recommended to consult an external specialist or undergo specialized training.
- Refers to range of experimental techniques in which the process is 'experimented on' in a controlled environment and the result observed are analyzed for different relations.
- Scientifically designed experiments are performed on a process to analyze different parameters related to it.

E.g. Suppose a project is taken up towards controlling the thickness of steel emerging from rolling process as below:



Factors that can affect the output thickness:

- ✓ Original thickness
- ✓ Roller Pressure
- ✓ Roller speed
- ✓ Steel Temperature

A planned series of Experiments may be taken to ascertain the effect of different factors on output thickness.

Mathematical Operations behind the DOE are same as that of regression analysis but the difference between regression analysis and DOE lies in fact that regression analysis is generally used to analyze historical data from a process in normal mode. While, designed experiments are used to create and analyze real time data which is taken from process in experimental mode.

Some Tools for generating MFCA Kaizens

Skill Enhancement

Sometimes it is observed that some abnormal losses occur due to existence of gap between the required skills and the existing skills of the employee or their unawareness. So, it becomes an imperative to impart training and awareness to employees performing the specific task they are assigned to.

It requires active role from line managers and HR of the organization to continuously evaluate the skill of employees and upgrading them to required levels.

Other tools which may useful for MFCA kaizens:

- ✓ Root Cause Analysis
- ✓ Man-Material Movement charts
- ✓ Inventory Turnaround ratio Analysis.

Sustainability of MFCA

Sustaining and Institutionalizing MFCA in any organization requires:

- ✓ Continual Improvement Focus by management.
- ✓ Sustained team effort by the employees.
- ✓ Participation across all levels.
- ✓ Brainstorming.
- ✓ Celebration of achievements.
- ✓ Kaizens

A successful MFCA programme involves continual implementation of PDCA cycle which becomes PDCA Spiral wherein one PDCA Cycle gives input to next PDCA cycle to keep on improving.

MFCA enables…..

- ***Visualization of Material Losses within Organization/Supply chain.***

    - ***Improving coordination and awareness for material and energy usage.***

- ***Improves Process Efficiency.***

    - ***Reduced Environmental Footprint.***

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