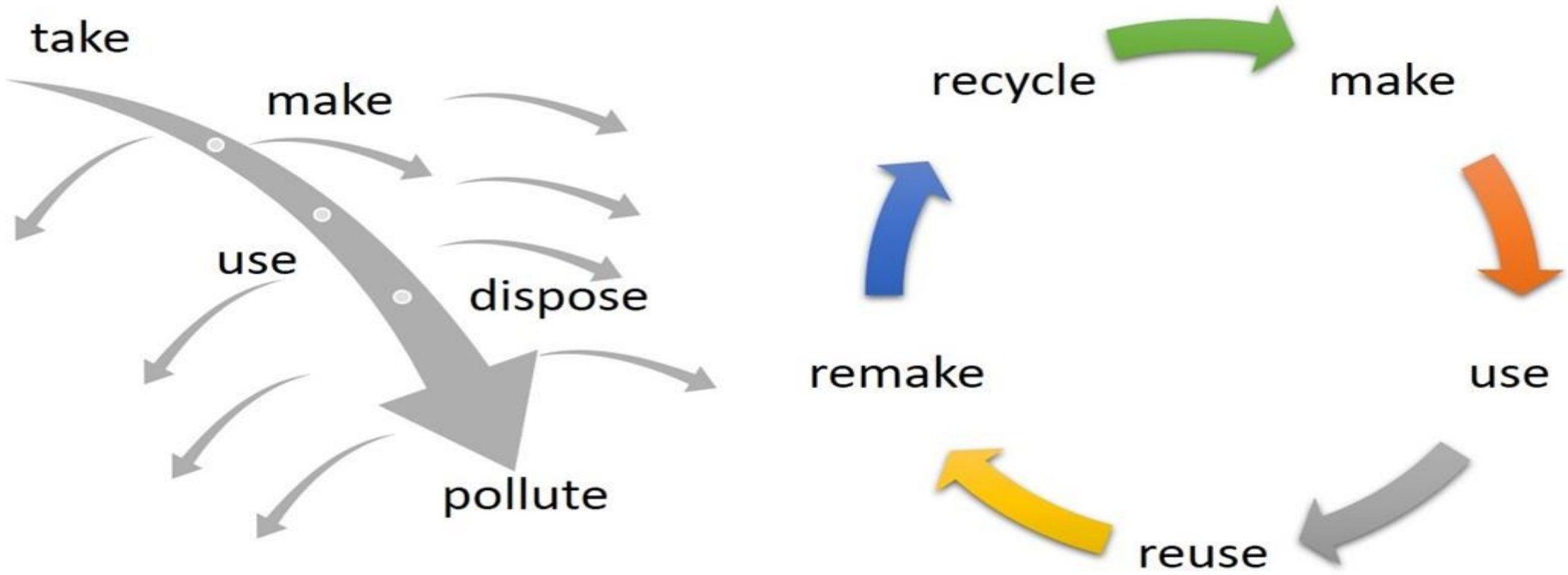

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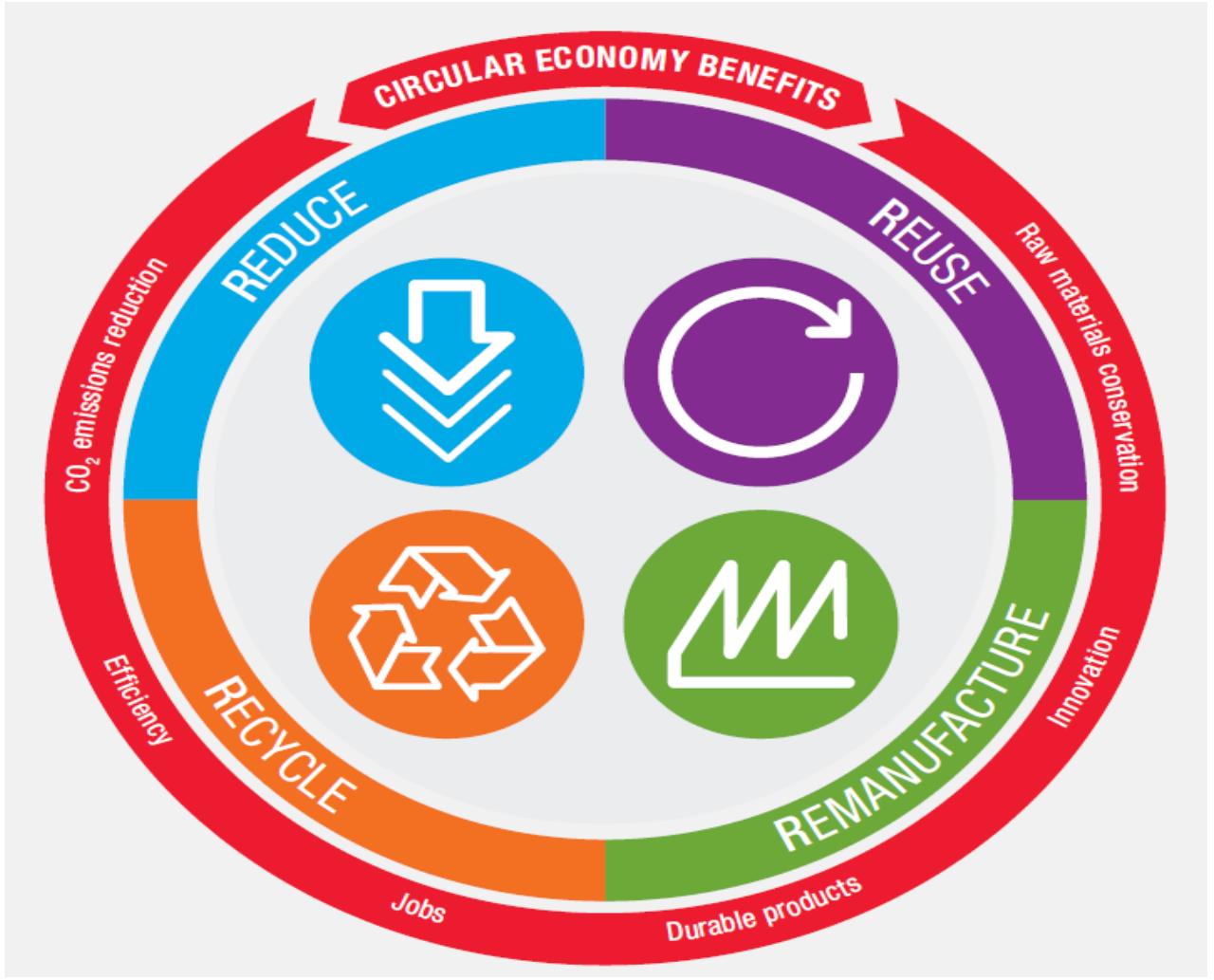
Design-To-Cost Remanufacturing of the Radar Systems

ICoR-2019 - Khalid Mahmood

Remanufacturing Process

- A series of manufacturing steps acting on an end-of-life product, in-order to return it to like new or better performance, with a warranty to match.
- Normally Remanufactured units are sold at 70% of the price of New Unit.
- Provide ideal EOL solution for the High Value sectors or fleets



DTC Re-manufacturing of the Radar Systems

- Design-To-Cost remanufacturing research provides inside issues of the cost estimation in the Marine industry; problems, knowledge gaps and best current practices in use for the DTC and a parametric cost trade-off for reducing overall life cycle costs for manufacturing & remanufacturing of the radars

Reuse, repair, remanufactured, recycled & reconditioned. These methods have been “ranked” into a sequence [29], as show below in the Figure 1: Self-Replenishing Loop.

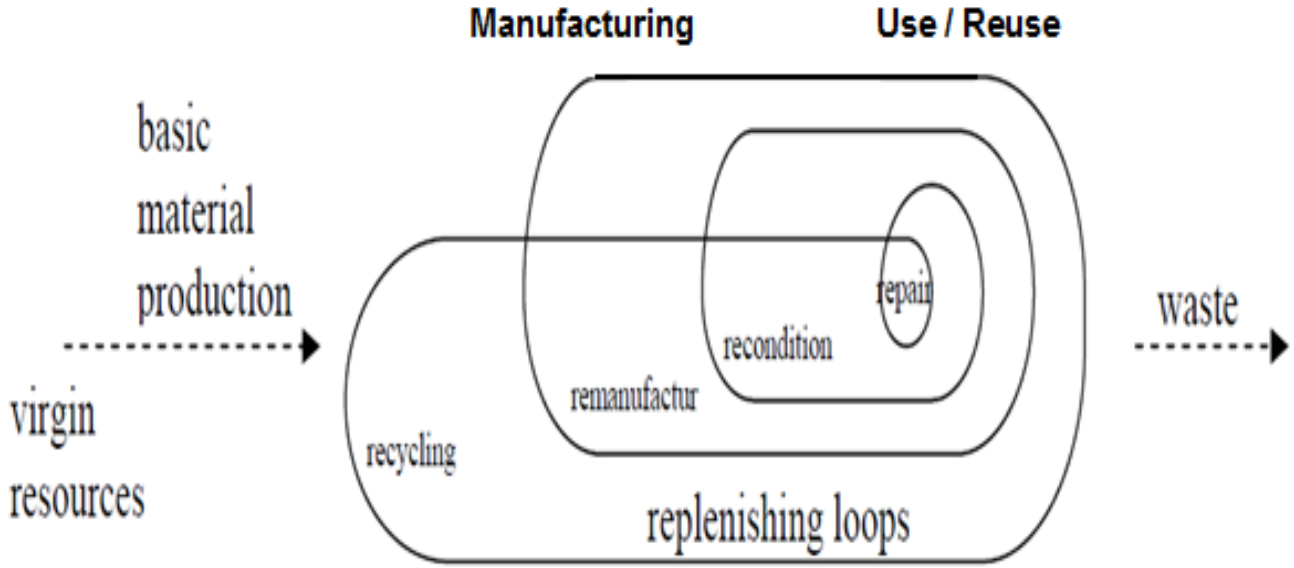


Figure 1: Self-Replenishing Loop **Source:(Stahl, 1982)**

DTC Remanufacturing of Radar System – Objectives

Core objective of this research can be summarized into the following four areas;

1. Identify cost drivers which are affecting the whole life cycle, find out more in terms of the Nonrecurring Costs (NRC), Product Remanufacturing Cost (PRC) and the Life Cycle Cost (LCC) drivers.
2. Understand the cost trade-offs between different product design & remanufacturing route cost drivers such as a make or buy them.
3. Develop a parametric estimation model of costing to validate cost trade-offs in terms of NRC, PRC and LCC drivers.
4. Highlights the recommendations on Design-To-Cost (DTC) and current best practices.

Parametric model-based design to provide support for decision making for the design and remanufacturing by showing the impact on costs throughout the entire Life Cycle.

Taxonomy of Years in which Papers were Published

In Marine industry remanufactured unit is called **SPEX Units,** which been through One Life Cycle years in the Vessels and returned to the OEM for Remanufacturing during which, it was disassembled up to the Core, then remanufactured according to Original Product design Specification, with the latest Quality and Software updates;

- **SPE** = Manufactured according to Specification, X = Exchange unit
- Letter X is used in the ERP system to identify it is an Exchange (Reman) Unit.
- Revision levels R1, R2 …. RN, used to identify no. of Remanufacturing loop.

Taxonomy of Years in which Paper was Published	
Reference	Year
Myers et al (1978), Muiga and Reid (1979), Brideman et al. (1979)	1978- 1980
NASA (1983), Chandler (1984), Purdy and Wiegmann (1987), Owusa-Ababio and Collura (1989), Gogies et al. (1990),	1981-1990
Martin (1992), Bradford and Eck (1994), Sneed (1995), Adams and Kim (1998), Lofsten (1999), Al-Subaibani and Wahby (1999), Otrtiz-Garcia (1999), Edwards (2000), Ijomah, W., (1998).	1991-2000
Brown and Hockley (2001), Zoeteman et al (2001), Edwards et al (2000), Larsson, D and Gunnarsson (2001), Vatn (2002), Dipl.-Ihg (2002), Schlickman (2002), Stalder (2002)	2001-2010
APRA (2012), Xu,X., Liu, K., (2009), Xu, X., Li, Y., (2016), Xu, X., Gursoy, D., (2015), Xu. X., Munson, Zeng, S., (2017), Wang, W. Tseng, M.M., (2017), Touboulie, S., Sinha, K.K., (2011)	2010-2018

Research Methodology

Design Costing Initial Review

- Key focus areas are Cost engineering, Cost-estimation technique, DTC remanufacturing knowledge of the radar systems for the following areas; Application, Cost Estimates, Design to Cost, Radar Configuration and Cost Trade Off techniques…

Cost Estimation

- Cost estimation is required by the Product Line Managers which needs to know, what is required to complete the Costing tasks in terms of lead time, product before and after remanufacturing in-order to develop an optimal asset management strategy with a low-cost model. This main that different techniques are used for the cost estimation such as bottom up approach, feature based revisions, design to cost, analogy and the parametric cost driver [14].

Design-To-Cost (DTC)

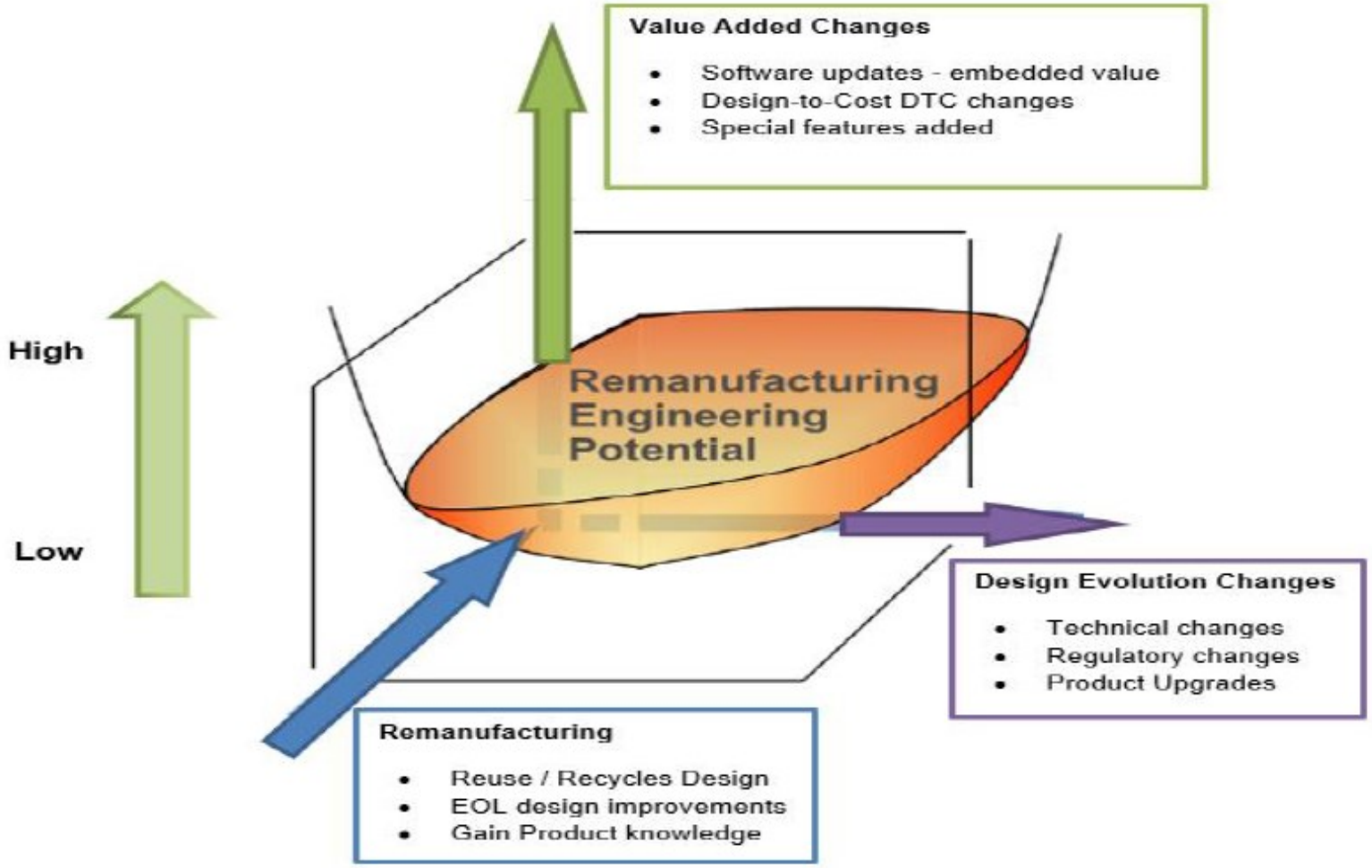


Figure 2: Remanufacturing attributes – feasibility space Source: (Oakdene Hollins, 2014)

- Design-to-Cost is a cultural change for the organisational behaviour where cost is driven an equal or greater weighting than a trade. The aim of Design-To-Cost is to minimize Life Cycle Cost by looking at the process [2].

Remanufacturing Cost Estimation

Qualitative Technique

Qualitative cost estimation techniques are mainly based on comparative manufacturing life cycle cost analysis of the product remanufacturing with the manufacturing cost previously known drivers.

The qualitative technique can be classified into the following two types;

- **An Intuitive Technique**
- **An Analogical Technique,**

- Companies must consider about cost drivers at all levels of the business to exist, in-order to win more customers and sustain market share, as they incur so that their final products are priced competitively along with superior quality [14].
- The Association for the Advancement of Cost Engineering (AACE) describes the production, remanufacturing cost estimating as the “predictive process used to quantify, the cost and price resources as required by the scope of an asset investment option or cost saving projects”.

As shown below in the Figure: Reman Cost Estimation.

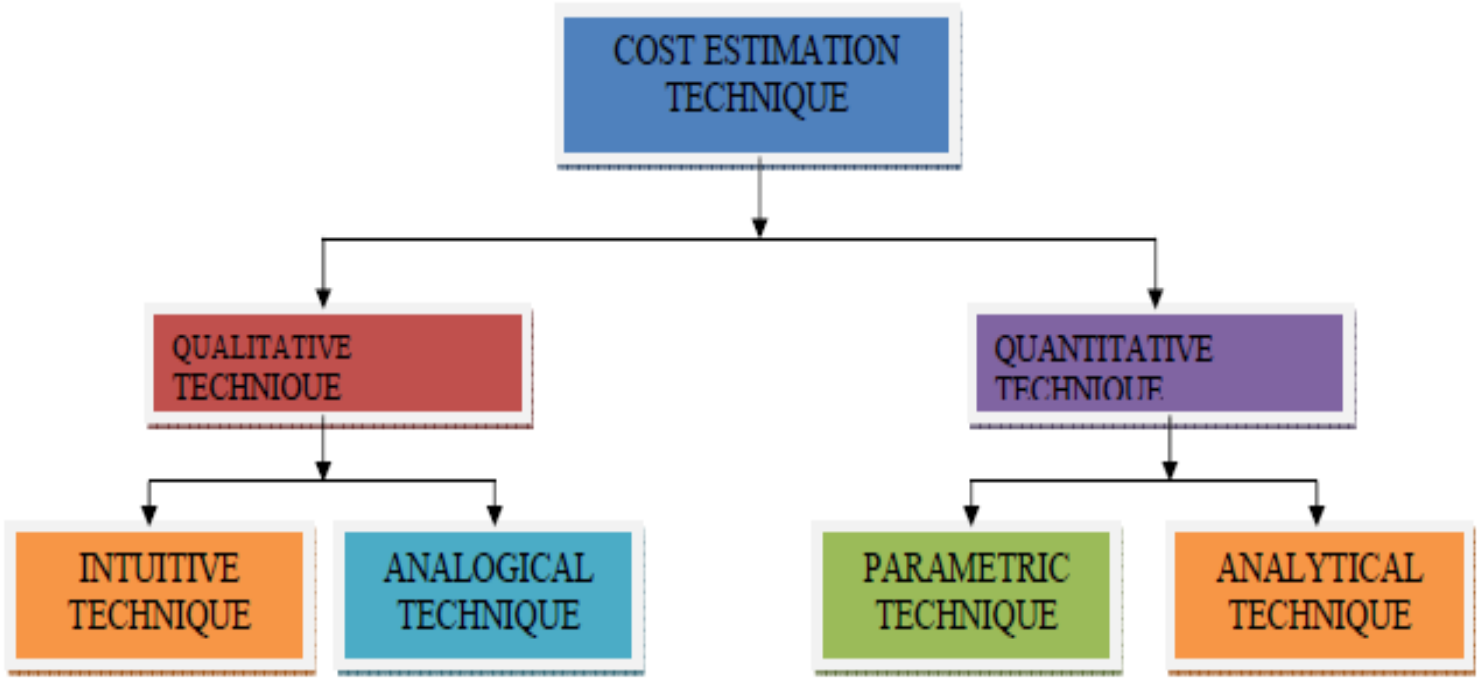


Figure 4: Reman Cost Estimation Techniques **Source: (Niazi et al., 2006)**

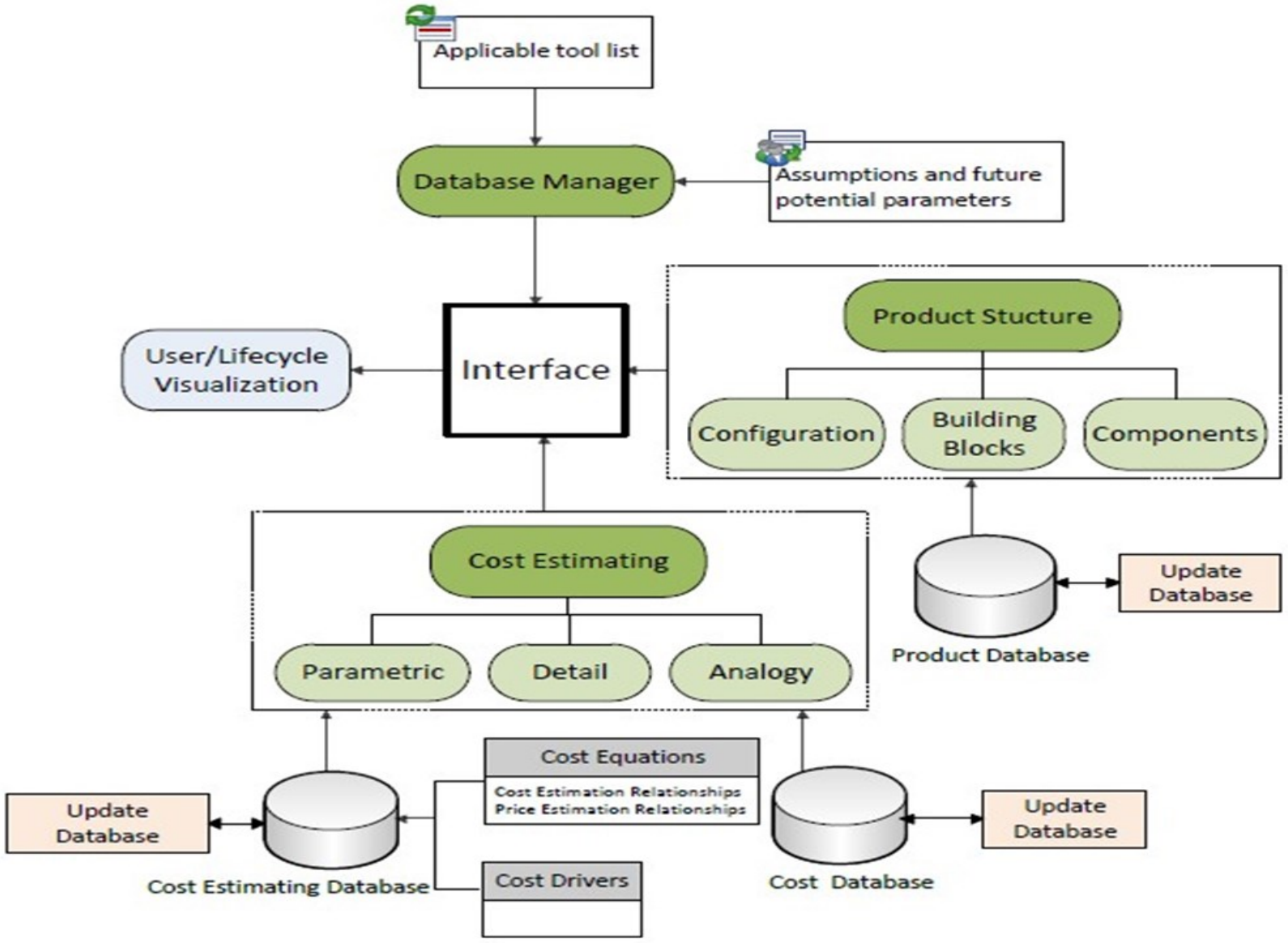
Literature Review

Literature Review

The Literature Review has highlighted the following areas to focus;

1. **Application,**
2. **Design to Cost,**
3. **Cost Trade-off**
4. **Cost Estimation tools**

Cost Estimation Model Structure



- **Cost Estimation**

"Cost estimation is a forecast of costs based on a logical extrapolation of available historical data".

Conclusions

- The majority of the organizations, needs to define products as a top level of component which drives the major costs.

- Create DTC Cost Reduction platform, which provide support for the Costing at all levels and should get the same attention, such as Product Quality, Key Performance & Continuous Improvement.

- Cost Vs Price Target should be reviewed every 3 years by the DTC Team with the support of Production and Manufacturing Managers.