# Chapter 1: Prelude

This Chapter puts up the precursory business management problem inspiring this research, and also appraises the reader of the basic keys to engineering design management.

## 1.1 Problem Statement

*The companies who do not have effective design management practices/models are much less successful in business than the ones having it* (Bruce, Cooper, & Vazquez, 1999).

## 1.2 Background & Motivation

"Engineering Design is a systematic & intelligent process in which designers focus skills & knowledge to generate, evaluate and specify concepts for devices, systems or processes whose form and function achieve clients' objectives or users' needs for an optimum engineering solution while satisfying a specified set of constraints" (Dym, Agogino, Eris, Frey, & Leifer, 2005; Dutta, 2013a). Piping Engineering Design is a domain of mechanical engineering design (Tsai, Yang, & Liao, 2011) that studies the efficient transport of fluid or pressure from one point to another (ASME, 2014). Project Management is the art of making the right

decisions in a customer-oriented way when faced with an array of alternative choices (Virine & Trumper, 2008; Dutta, 2013a). "Engineering Design Project Management or Engineering Design Management is the business side of design involving the interfacing of Engineering Design and Management united with the common goal of creating optimum engineering solutions for a better tomorrow" (Acklin, 2010; Design Management Institute, 2012; Dutta, 2013a). Successful management of engineering design is critical to cost-effectiveness, timeliness and quality of any engineering project and competitive advantage of the company (Chua & Tyagi, 2001; Heller, Jager, Schluter, Schneider, & Westfechtel, 2004; Andersen, Nycyk, Jolly, & Radcliffe, 2005; Owen, 2006; Mozota, 2006; Mozota & Kim, 2009; Mozota, 2010). *Previous* research has proven that the more effective the design management practices of a firm are, the more the firm is successful in business (Bruce, Cooper, & Vazquez, 1999).

Piping Engineering Design Management (PEDM) is the business side of piping design involving the *interfacing of Piping Engineering Design and Management united with the common goal of creating optimum engineering solutions* for a better tomorrow (Acklin, 2010; Design Management Institute, 2012).

Management of Engineering Design can be traced back to the need based quest for bridging the gap between engineering design & corresponding business management, and this led to the birth of Design Management in 1944, when warfare & industrial needs drove the development of the British Design Council - Council of Industrial Design with the objective of promoting business practicability of engineering design (Wolf, 1993).

Researches have time & again proved that the design engineering role is of centrally pivotal importance to organizations engaged in product development (Pahl, Beitz, & (Ed.) Wallace, 1996; ASME, 2013, 2014; BSI, 2014) particularly

as ***80-90% of production costs are determined at the conceptual design stage*** (Barbeau, 1998).

The crucial importance of design management in any organization's capability development is a widely accepted research proven fact (Owen, 2006; Mozota, 2006; Mutanen, 2008).

The criticality of the management of piping engineering design lies in the fact that ***piping consumes more than 40% of any plant's design engineering activities*** (Sheremetov, Batyrshin, Chi, & Rosas, 2008). Piping is popularly compared to the arteries in human body and, the adage that piping study is 'half science and half art' is true, the art part is visualization and creativity while the science part refers to following the established norms (Prasad, 2009).

From a comprehensive review of existing literatures on the subject, it has been found that the entire cycle of design management consists of six phases (Howard, Culley, & Dekoninck, 2008) discussed later & each phase consists of *two main interfering sectors – 1. the Design Product Engineering Side consisting mostly of the actual engineering design execution activities like CAD, Computer Aided Engineering (CAE), design optimization & product quality assurance, and, 2. the Design Process Side consisting mostly of the management of the associated design activities of the design product* like design knowledge management, design cycle sequencing-controlling-monitoring, conflict management, interdisciplinary management, innovation integration, feedback integration, non-value adding activities' identification & elimination, design change order management, rework minimization & design project work management (Visser, 1996; Lee, Sause, & Hong, 1998; Swink, 2000; Dutta, 2013a).

From the review of existing literatures, it has been further found that although there have been some researches on the Product Side, however, no

evidence of research has been found on the Process Side or on the Product-&-Process-Sides-Integrated-Cycle of Piping Engineering Design Management (Dutta, 2013a).

But, since effective management of engineering design is critical to the competitive advantage of any engineering company, hence the research scholar has been motivated to research in this arena (Integrated Cycle of Piping Engineering Design Management consisting both the Product & the Process Sides).

This is the theoretical reason why the researcher chose this particular research. In addition to this, a part of the researcher's inspiration for this research can be traced to his practical piping engineering design management experiences in top oil & gas companies of India and abroad. It all started when the researcher has been practising as a design engineer in the very early stages of his career. During the course of his work, he noticed that different design managers manage engineering design in their different unique styles. And each style has some advantages as well as some inherent managerial flaws that are specific to the individual design managers but these diverse flaws affect the design output in the same way. For example, biased subjectivity (instead of objectivity), innovation mismanagement, etc. & these affect the design output quality negatively. The researcher's further piping engineering experiences in different engineering companies (mainly oil & gas) working under different design managers only reinforces what he felt earlier thus making him experientally realize a Practical Gap: there is no well-defined system to manage piping engineering design, thus allowing human flaws or Managerial Flaws to negatively affect the design output. This is unlike the engineering/technical aspect of engineering design wherein Codes & Standards (for e.g. ASME, BSI, ISO, NORSOK, IS, IBR, etc.) ensure that Technical Flaws do not hamper the design output, at least to a basic extent.

All these discussed factors, tripled with the facts that piping engineering design management comprises of more than 40% of any plant's design engineering activities (Sheremetov, Batyrshin, Chi, & Rosas, 2008) and 80-90% of production costs are dependent on the design stages (Barbeau, 1998), have been a constant source of motivation for the research scholar, inspiring him in this research.

In this Chapter the inspiration for this research has been discussed along with some basic key understandings of engineering design management. The proceeding Chapter introduces the indispensable business need for this research and depicts the flow of chapters in this thesis.