

# Shape Memory Material Manufacturing Design Optimization and Stress Analysis

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*Abstract: A recent breakthrough in the development of shape memory materials has demonstrated promising applications for completion products in the oil and gas industry. In one of the targeted applications, shape modification is a major step toward commercialization of this technology. Efficiently and effectively reshaping the material is a key element for final production. The goal of our technical team is to design and optimize the reshaping equipment so as to enable production quantities of tools while maintaining material properties. Many factors could affect the reshaping of the shape memory material such as reshaping profile, length, available compaction force, compaction speed, shear deformation, and damage to the material. In order to achieve better understanding and obtain optimized parameters, material reshaping was extensively investigated through numerical modeling and advanced finite element analysis. This paper will cover the concepts, challenges, and finite element modeling of reshaping shape memory materials. Detailed deformation and stress distribution of the material were obtained and analyzed to guide the equipment design.*

*Keywords: Shape Memory Material, Completion Products, Design Optimization, Experimental Verification.*

## 1. Introduction

The unique characteristics of shape memory materials are attractive to many applications where transition between a temporary shape and a permanent shape is necessary. In the past decades, shape memory materials have been used mostly in industrial applications, biomedical fields and other related applications. Due to the downhole harsh environment of oil and gas industry, the application of shape memory materials in this industry was limited and discovered only recently.

In our target applications, the permanent shape is desired at downhole. However, in order to achieve this permanent form, a temporary shape must be manufactured and then delivered to downhole. Thus, the reshaping process becomes a key element of the target applications. Since the manufacturing process may introduce detrimental changes to the material mechanical properties, how to minimize the manufacturing impacts becomes the major challenge of this reshaping process. More importantly, an optimized manufacturing process may yield lower cost and consume less energy while maintaining the highest productivity.