

From Analog to Digital: An In-Depth Cost Analysis of Dental Prosthesis Manufacturing Techniques

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Additive manufacturers are creating high-precision dental prostheses using the selective laser melting process and want to move the market from traditional model casting to digitized 3D printing. Although this technology is already a decade old and costs up to a quarter less to produce, additive manufacturers are only taking over less than 10% of the market. This study discusses the economic aspects of both processes and provides a transparent view of the topic.

State of the Art

The traditional manufacturing process for removable partial dentures (Fig. 1) involves a large number of complicated manual steps that are very time-consuming and therefore expensive. Additive manufacturing overcomes some of these issues with the digitized creation of the framework and the comparison of accuracy using modern scanners. Although the additive variant has been available for a decade, only less than 10% of prostheses in Switzerland adopt it, and important cost issues are not dealt with publicly.

Methods

This study is based on five case studies. Due to the generalized manufacturing methodology of the Swiss m4m Center in additive manufacturing, it assumes the role of the only digital reference in this work, while a total of four different dental technicians were visited, as the variance in analogue processes is greater. Once a general understanding of the as-is processes was established (Fig. 2), the various cost items such as machine costs, overheads and material costs as well as the times used for each process step could be recorded for each process. Due to different geometries, the products were divided into different complex categories. The aim of this study is to illustrate these differences in economic terms and to create a transparent understanding of the two processes and their associated costs.

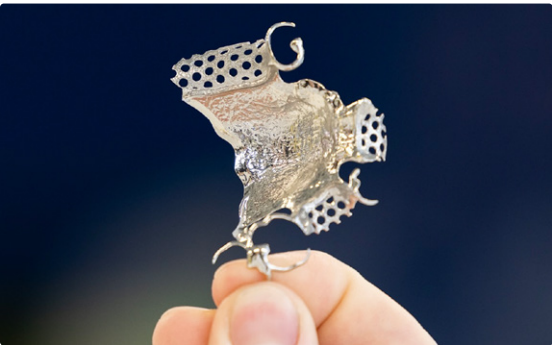


Fig 1: Digitally manufactured dental prosthesis made of cobalt-chrome

Results

By collecting cost data, 60 process steps each and over 280 different cost items were recorded and analyzed. An Excel tool was created to document labor times and all necessary cost items to calculate the manufacturing costs with variables for each process. Manual labor time is the biggest cost factor for both manufacturing techniques and uses around 2.05h for additive manufacturing, while that of the analog method takes 3.2 hours on average. The machine time of additive manufacturing is more than 50% higher than analog manufacturing. The manufacturing costs of additive manufacturing are 7% lower for individual production and around 25% lower for the current capacity utilization of Swiss m4m. At 13%, differences in geometry have less of an impact on manufacturing costs in additive manufacturing than in analog manufacturing, where they average 19%.

Future Research

This study has primarily focused on the economic aspects of dental prosthesis manufacturing techniques. An important factor that remains to be explored is the quality of the prostheses produced by each method, which could be addressed in a further study. The same applies to the topic of designing the prosthesis in-house in additive manufacturing, which is currently designed off-site.



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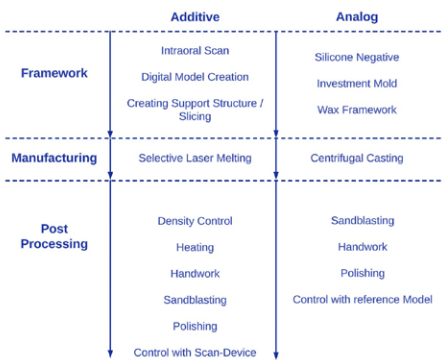


Fig 2: Process differences between digital and analog workflow