



# Götz Prosthesis Reconstructions



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## Research Topic

The 3D CAD reconstructions and 3D multimaterial polymer replica printings of knight Götz von Berlichingen's first "Iron Hand" were developed in the last few years at Offenburg University and are still subject to ongoing research. Even by today's standards, the first "Iron Hand" demonstrates sophisticated mechanics and well thought-out functionality and still offers inspiration to the question of an artificial prosthetic replacement for a hand.

## The first and second hand

The famous Franconian knight Gottfried (also called "Götz") von Berlichingen (1480–1562) lost his right hand due to a cannon ball splinter injury in 1504 at the age of 24 years [5]. Götz commissioned a gunsmith to build the first "Iron Hand". In this prosthesis, the artificial thumb and two finger blocks (index and middle finger, and ring finger and little finger, respectively) could be moved in their basic joints by a spring mechanism and released by a push button. Photographs of the first hand can be seen under the following permalinks:  

Some years later, presumably around 1530, a second "Iron Hand" was built. In this, the fingers could be moved passively in all joints. Photographs of the second hand can be seen under the following permalinks:  

Although the second prosthesis was more elaborate than the first prosthesis, it seems that the knight continued to use the first one much more often.

## The First 3D CAD Reconstruction

The first 3D CAD reconstruction [8] of the first "Iron Hand" was based on data from Quasigroch, 1982 [6]. This 3D CAD reconstruction was then printed with a multi-material printer (Stratasys J750, Eden Prairie, MN, USA), which allows for the production of different polymer materials (including transparent, non-transparent, stiff, or elastic components)[4] (Figure 1).

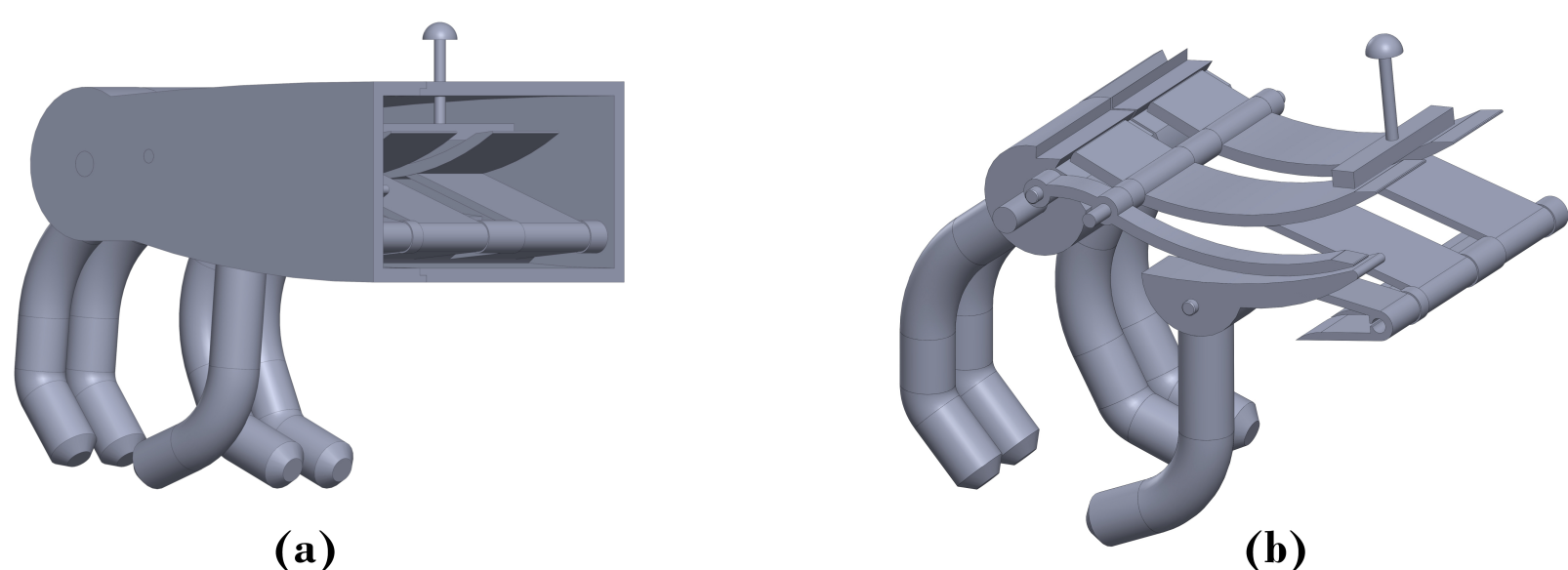


Figure 1: Initial 3D computer-aided design (CAD) reconstruction

In our investigations with the 3D-printed polymer replica, we found that simple actions for daily use, such as holding a wine glass, a mobile phone, a bicycle handlebar grip, a horse's reins, or some grapes, are possible without effort [3].



Figure 2: Initial 3D-printed polymer replica.

## Optimized Opening Mechanism by a Torsion Spring

During the use of the initial 3D reconstruction of the hand, it was observed that the thumb lever broke under greater stress. The increased forces mainly in the thumb lever could be confirmed by finite element method (FEM) analysis [2]. Therefore, the mechanism of the thumb lever was revised by two power levers that move in opposite directions when the thumb is moved. Additionally a resetting mechanism was implemented so that, when the reset button is pressed, the fingers rebound to their original position. For this purpose, a torsion spring was integrated into each finger block [1][7].



Figure 3: Second 3D-printed polymer replica of the first "Iron Hand" of Götz von Berlichingen with an improved thumb lever mechanism. (a) General view of the artificial prosthetic hand; (b) view after removal of the lateral chasis cover with insight into the new mechanics.

## References:

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