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**The Babe Zaharias Medals: Exploring Methods of Replication for a Promising Non-Contact Based Approach**

Throughout my time in the OUR program I was able to explore four different methods of non-contact replication for the protected recreation of the Babe Zaharias medals. The medals won by Mildred “Babe” Didrikson Zaharias not only showcase her great athletic ability but show the resilience, hard work, dedication, and result of a woman in sports in the 20th century. We aim to recreate these medals in order to preserve Babe’s legacy and inspire future generations. Since her story is encased in her medals, we must reduce any risk of damage to the historic pieces. Thus, our research focused on testing the efficacy, and limitations of the following methods for non-contact replication: hand-sculpting, photogrammetry, digital sculpting, and profilometry.

<table>
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<th>Method</th>
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| Hand Crafted   | Measurement were taken of the medals and used to guide the creation of the replica by hand-sculpting. The materials used were polymer clay and available sculpting tools | ![Hand Crafted Result](image1) | • Lacks Precision  
• Rough texture  
• Uneven          | Low              |
| Photogrammetry | A series of photographs were taken from sequential angles and were uploaded in the photogrammetry program Meshroom. The program then interpreted and composited the two-dimensional photographic data into a three-dimensional model. | ![Photogrammetry Result](image2) | Program was unable to create a coherent mesh | N/A             |
| Digital Sculpting | Using available digital sculpting and modeling software, we first crafted the geometric base of the medals (left) and added subsequent details with the creation of a digital stamp (top right) which were enhanced by hand correction (bottom right) | ![Digital Sculpting Result](image3) | • Accurate  
• Smooth  
• But lacks unique surface textures | Medium with slight discrepancies |
| Profilometry   | Under Rice University’s Shared Equipment Authority (SEA) we were able to be trained and use the NP Flex Optical Profilometer (Bruker, Billerica, MA) to obtain surface information of the medals by use of reflected light. | ![Profilometry Result](image4) | • Captures surface texture  
• Missing some surface information  
• Only raw data was able to be exported | High             |
Discussion and Conclusion

Handcrafting and photogrammetry resulted in often inaccurate or distorted models that needed much refinement. Meanwhile, the approach of digital sculpting resulted in a clean but simple model of the medal which often lacked specific detail. When attempting to imprint fine detail in digital sculpting method, detail may become distorted and need much refinement by hand which opens-up the possibility of human error during replication. The profilometry approach yielded a high detail scan of small areas, however the scan was not without problems, as the scan presented areas of missing information. Therefore, our conclusion for our current research is that instead of limiting the replication process to one certain approach, varying successful approaches should be incorporating within the final method. Through our research we now hypothesized that a potential successful approach to replicating the Babe Zaharias Medals is by first creating a simple geometric base in a digital modeling program. Next, a high-quality photograph is taken of any specific detailed design and used to create a digital 3D stamp. The geometric base is then imported into the digital sculpting software, and the stamp is used to create an imprint where needed. The raw data points collected from the profilometer scanning would then be imported and placed above the low-quality imprint made. Since the profilometer data provides information of detail height, these will be used to guide the vertical height of the detail within the medals. By combing these approaches, they would allow for a clean base and allow for the creation of detailed organic forms such as the eagle to be guided by computer generated data thus reducing human error. In conclusion, approaches to replication should not be limited to a single approach, but instead have various successful approaches be applied. By exploring non-contact replication, we not only are one step closer to preserving Babe’s achievements but may also contribute a method to be used for other historical pieces.