

**Design and Fabrication of Patient-Centered 3D Hearing Aid Shells: A Multidisciplinary Approach for Collaborative Management of Hearing Loss**

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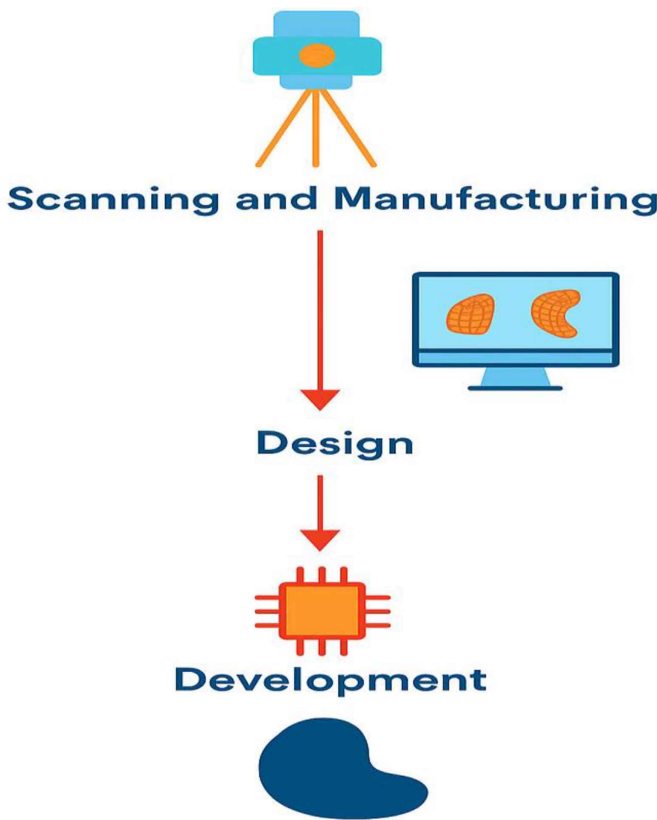
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**Background**

Hearing is part of people's lives and an adequate connection with the surrounding world depends, among other things, on the detection and discrimination within the auditory space<sup>1</sup>. Hearing aids (HAs) are effective at improving listening ability, communication skills, and general health-related quality of life in subjects with hearing impairment<sup>2</sup>. There is no permanent cure for hearing loss, and the main form of clinical intervention is wearing hearing aids. Using hearing aids has been shown to improve hearing function for mild to moderate or severe hearing loss, as well as positively influence quality of life through enhancing communication<sup>3, 4</sup>. Despite these benefits, hearing aid use is low and approximately 30% of people report wearing hearing aids some of the time and 20% do not wear them at all<sup>5</sup>. Furthermore, many people live with hearing loss symptoms for a long time (on average, up to 10 years) before seeking help<sup>6</sup>. Understanding the reasons why hearing aid usage is low and gaining insight into why people do not seek help are important research priorities. The illness burden of hearing loss is considerable. Hearing loss makes it hard work to communicate and increases risks in all aspects of life<sup>7</sup>. Many individuals with hearing loss avoid hearing aids due to inadequate counselling, misconceptions about effectiveness, and discomfort. Poorly designed hearing aid shells that cause irritation or do not fit the ear canal properly also discourage use. Unattractive designs, stigma, and lack of proper guidance further reduce motivation for consistent use.

The integration of cutting edge technology with multidisciplinary team of experts is vital in improving hearing aid design and rehabilitation outcomes. Hearing aid shells protect fragile acoustic components, play a critical role in the provision of comfort, fitting, and functionality for people with hearing loss. Traditional fabrication processes, frequently present limitations in customization and patient satisfaction. The process starts with guidance counsellors providing psychosocial support and counseling to ascertain patients preparedness, acceptability and consistently use of hearing aids so that the aids will not end up in drawers. Audiologists take accurate ear impressions and digital scans, capturing detailed auditory canal morphology. Orthotists with their technical prowess in 3D modeling, ergonomics, and additive manufacturing to design biocompatible shells that boost comfort and acoustic sealing.

Otorhinolaryngologists provide clinical oversight, making sure the shells are anatomically safe and malleable to pathological variations of the ear. Additive manufacturing is carried out mostly with the use of stereolithography with medical-grade UV resins.



**Figure 1: Patient-Centered 3D Hearing Aid Shell Design and Fabrication Process**

Existing researches have demonstrated that multidisciplinary team collaboration significantly improved outcomes. Patients reports greater comfort, reduced feedback, and better adaptation to hearing aid use compared to traditionally fabricated shells. In addition, the introduction of guidance counsellors enhance patient acceptance and adherence, combating psychosocial barriers to hearing aid uptake and use. The collaboration of professionals reduces production errors and turnaround time, it also enhances precision in fitting.

This review delves into the design and fabrication of custom 3D hearing aid shells using a collaborative approach involving guidance counsellors, audiologists, orthotists, and otorhinolaryngologists. It also underscores the transformative potential of incorporating clinical, technical, and psychosocial specialists in hearing rehabilitation. Custom 3D-printed hearing aid shells that are designed through this collaborative model produce superior patient-centered results with emphasis on a broader application of multidisciplinary approaches in audiological care.

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