

## **Designing and Using a 3-D Printed Dynamic Upper Extremity Orthosis (DUEO) with Children with Cerebral Palsy and Severe Upper Extremity Involvement**

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**Abstract :** Children with cerebral palsy (CP) commonly present with upper extremity impairment, affecting one or both extremities, and are classified using the Manual Ability Classification Scale (MACS). The MACS defines bimanual hand abilities for children ages 4-18 years in everyday tasks and is a gradient scale, with I being nearly normal and V requiring total assistance. Children with more severe upper extremity impairment (MACS III-V) are often underrepresented, and relatively few effective therapies have been identified for these patients. Current orthoses are static and are only meant to prevent the progression of contractures in these patients. Other limitations include cost, comfort, accessibility, and longevity of the orthoses. Taking advantage of advances in 3D printing technology, we have created a highly customizable upper extremity orthotic that can be produced at a low cost. Iterations in our design have resulted in an orthotic that is custom fit to the patient based on scans of their arm, made of rigid polymer when needed to provide support, flexible material where appropriate to allow for comfort, and designed with a mechanical pulley system to allow for some functional use of the arm while in the orthotic. Preliminary data has shown that our orthotic can be built at a fraction of the cost of current orthoses and provide clinically significant improvement in assisting hand assessment (AHA) and pediatric quality of life scores (PedsQL).

**Keywords :** upper extremity orthosis, upper extremity, orthosis, 3-D printing, cerebral palsy, occupational therapy, spasticity, customizable

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